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## DESCRIPTION

### IMAGE SIGNAL REPRODUCTION APPARATUS

#### 5 TECHNICAL FIELD

The present invention relates to an image signal reproduction apparatus for reproducing a video signal in a progressive scanning way by transferring various image information such as movie materials or video materials via  
10 optical disks such as digital video disk (DVD), video tapes, satellite broadcast, ground-based broadcast, and the like.

#### BACKGROUND ART

Conventionally, image outputs of DVD, satellite  
15 broadcast, and the like are commonly output by interlaced scanning so that the video outputs can be reproduced by an image receiver. Recently, image signal reproducing apparatuses for converting interlaced scanned image signals into progressive scanned signals are being introduced as  
20 monitors and projectors compatible with multi-scanning, or monitors for computers are becoming widespread.

Figure 39 is a block diagram showing a configuration of a conventional image signal reproducing apparatus. In  
25 Figure 39, reference numeral 1 denotes a disk on which a main image signal and a determination flag are recorded in an encoded and modulated signal form suitable for recording in advance. The main signal is either an image signal obtained by converting a film material into an electrical  
30 signal or an image signal of which material is a video signal. The determination flag shows whether the main image signal is of film material or video material. Reference numeral 2 denotes a pickup which converts the signal recorded on the

disk 1 into an electrical signal. Reference numeral 3 denotes a disk rotating device which rotates the disk 1 at a certain revolution-per-minute suitable for the disk 1. Reference numeral 4 denotes an interlaced scanned video  
5 signal reproduction circuit which demodulates and decodes the main image signal recorded on the disk 1, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 5 denotes a first memory which functions as a buffer memory when the interlaced scanned image signal  
10 is reproduced. Reference numeral 6 denotes an NTSC encoder which converts the interlaced scanned image signal into an NTSC video format and outputs the result. Reference numeral 7 denotes an interlaced scanned image output terminal through which the reproduced interlaced scanned  
15 image output is output. Reference numeral 8 denotes a first material determination circuit which reads the determination flag recorded on the disk 1 from an output of the pickup 2. Reference numeral 9 denotes a field repeat signal generating circuit which generates a field repeat  
20 signal when the interlaced scanned image signal reproduction circuit 4 converts the main image signal into an interlaced scanned image signal in the case when the main image signal is of film material. Reference numeral 10 denotes a progressive scanning conversion circuit which  
25 converts an output of the interlaced scanned image signal reproduction circuit 4 into a progressive scanned image signal and outputs the result. Reference numeral 11 denotes a second memory which is capable of storing a field of image signal and which is used in the operation of the  
30 progressive scanning conversion circuit 10. Reference numeral 12 denotes a D/A converter which converts an output of the progressive scanning conversion circuit 10 into an analog value and outputs the result. Reference numeral 13

denotes a progressive scanning image output terminal through which the progressive scanned image signal is output to an image display apparatus not shown.

5           The operation of the conventional image signal reproduction apparatus thus constructed will be described.

10           Figure 40 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the conventional image signal reproduction apparatus. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, vice versa. In the progressive scanned image signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480.

20           Both signals have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

30           Figure 41 is a schematic signal diagram showing a structure of the image signal recorded in the disk 1 of the conventional image signal reproduction apparatus. As shown in Figure 41, the image signal recorded in the disk 1 has two forms. Specifically, Figure 41a) shows a film material. In this case, the original material is a film image composed

of 24 frames of pictures per second. Each frame of the film image is compressed and recorded onto the disk 1 as an image of 720x480 dots. Figure 41b) shows a video material image. In this case, the original material is an interlaced scanned image composed of 30 frames/60 fields per second. Each frame is an image of 720x480 dots, but interlaced, so that each field is an image of 720x240 dots. The field is compressed and recorded onto the disk 1. As shown in Figure 41, the determination flag, which shows whether the main image signal is of film material or video material, is recorded on the disk 1 along with the main video signal.

Figure 42 is a schematic signal diagram showing a reproduced signal from a film material disk of the conventional image signal reproduction apparatus.

When the material of the image signal recorded in the disk 1 is a film, 24 frames of images of 720x480 dots per second are recorded. The interlaced scanned image signal reproduction circuit 4 reads the signal recorded on the disk 1 from an output of the pickup 2. A first material determination circuit 8 reads the determination flag from an output of the pickup 2 and determines the type of the main image signal, and outputs the resultant type as a determination signal to the interlaced scanned image signal reproduction circuit 4 and the field repeat signal generation circuit 9. Based on an output of the first material determination circuit 8, the interlaced scanned image reproduction circuit 4 recognizes that the main image signal recorded in the disk 1 is of film material. As shown in Figure 42, the film material images are recorded in the disk 1 in order of the frame numbers ..., n, n+1, n+2, n+3, ... The film material signal thus recorded is converted into

an interlaced scanned image and output by the interlaced scanned signal reproduction circuit 4. This is because television monitors are commonly used as an image display apparatus for home entertainment, and the display format is the interlaced scanning. Since the television monitor is designed to display a moving image of 30 frames/60 fields per second, the interlaced scanning video signal reproduction circuit 4 converts 24 frames of images per second into 30 frames/60 fields per second and outputs the result. The interlaced scanning video signal reproduction circuit 4 divides each frame of recorded information into two interlaced scanned field images, odd and even, as shown in the interlaced scanned reproduced image signal in Figure 42. The interlaced scanning video signal reproduction circuit 4 further displays the head field after the last field of each frame in response to the field repeat signal repeated every 5 fields output from the field repeat signal generation circuit 9 so that 24 frames of film images per second are converted into the interlaced scanned images of 30 frames/60 fields per second which are output. The first memory 5 functions as a buffer memory when the interlaced scanning video signal reproduction circuit 4 reproduces an image. The interlaced scanning video signal reproduction circuit 4 outputs a breakpoint between frames of the interlaced scanned image signal thus generated as the field repeat signal to the progressive scanned conversion circuit 10 as shown in Figure 12. The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced scanned image output terminal 7. A television monitor (not shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the

interlaced scanned image on the monitor.

Further, the interlaced scanned image signal reproduced circuit 4 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 10. The progressive scanning conversion circuit 10 recognizes that the input digital image signal is of film material, based on the presence or absence of the field repeat signal output of the field repeat signal generation circuit 9. Specifically, when the main image is of film material, the field repeat signal output from the field repeat signal generation circuit 9 changes to a 5 field period as shown in Figure 12. Such a change is detected, and it is determined that the main image is the film material. Accordingly, the progressive scanned image conversion is performed. In the case of the film material, for each frame of each material, the original image of 720x480 dots is divided into two fields of 720x240 dots. Therefore, these fields are synthesized again. Accordingly, the progressive scanning conversion circuit 10 can detect the timing of switching of the frame of the film signal which is a material of the input digital image signal, based on the field repeat signal shown in Figure 42. The progressive scanning conversion circuit 10 stores the head field of the progressive scanning conversion circuit input shown in Figure 42 in the second memory 11 and thereafter stores the second field in the second memory 11, and reads both information for each line at a double speed, thereby obtaining the progressive scanning conversion output shown in Figure 42. The converted image signal is converted into an analog signal by the D/A converter 12, and the resultant analog signal is output through the progressive scanned image signal output terminal 13. A television monitor (not

shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13. The user can see the film material images restored to the progressive scanned image via the television monitor.

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Figure 43 is a schematic signal diagram showing a reproduced signal of the conventional video material disk.

10 In the case when the material of image signals recorded in the disk 1 is video, an interlaced scanned image of 30 frames/60 fields per second is recorded as recorded information, each field having a 720x240 dots image as shown in Figure 43. The interlaced scanned image signal reproduction circuit 4 reads the signal recorded in the  
15 disk 1 from an output of the pickup 2. The first material determination circuit 8 reads the determination flag from the output of the pickup 2 and determines the type of the main image signal, and outputs the determination flag as the determination signal to the interlaced scanned image  
20 signal reproduction circuit 4 and the field repeat signal generation circuit 9. As shown in Figure 43, the video material images are recorded in the disk 1 in order of the frame numbers ..., m, m+1, m+2, m+3, m+4, .... The interlaced scanned image signal reproduction circuit 4 outputs the  
25 video material signal thus recorded as the interlaced scanned image signal shown in Figure 43 without alteration. The first memory 5 functions as a buffer memory when the interlaced scanned image signal reproduction circuit 4 reproduces an image.

30

The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced

scanned image output terminal 7. A television monitor (not shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the interlaced scanned image via the monitor.

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Further, the interlaced scanned image signal reproduced circuit 4 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 10. The progressive scanning conversion circuit 10 recognizes that the input digital image signal is of video material, based on the presence or absence of the field repeat signal output of the field repeat signal generation circuit 9. Specifically, when the main image is of video material, the field repeat signal output from the field repeat signal generation circuit 9 keeps a 5 field period as shown in Figure 43. Such a situation is detected, and it is determined that the main image is the video material. Accordingly, the progressive scanned image conversion is performed while the main image signal is regarded as the video material. In the case of the video material, the progressive scanning conversion circuit 10 generates a progressive scanned image signal using two pieces of field information, i.e., current field image information and the previous field. In this case, the progressive scanning conversion circuit 10 also uses data for the previous field to interpolate in the vertical direction with respect to pixels having small movements between the current and previous fields of the progressive scanned conversion circuit input shown in Figure 43. With respect to pixels having large movements between the current and previous fields, vertical interpolated data is generated from upper and lower pixel data in the same field to obtain a progressive scanning conversion circuit output shown in Figure 43. The



converted image signal is converted into an analog signal by the D/A converter 12. The analog signal is output through the progressive scanned image signal output terminal 13. A television monitor (not shown) for the  
5 progressive scanned image signal is connected to the progressive scanned image signal output terminal 13 so that the user can see the video material image converted into the progressive scanned image via the monitor.

10           Figure 44 is a schematic signal diagram showing a reproduced signal from a disk, which is a film material disk partially including a recorded video signal, of the conventional image signal reproduction apparatus.

15           Even when the signal source is of film material, part of the signal source may be recorded as a video signal. This happens as follows. A film material may initially be recorded in a video or the like before being recorded on the disk 1. When the material as video is restored to  
20 24-frame information again, part of the material remains as video and is recorded in the disk 1. Specifically, when information to be recorded in the disk 1 is generated, a breakpoint between the frames of the original picture in the recorded video is found by detecting a matching every  
25 5 fields in the material recorded in the video of 60 fields, and the video is restored to 24-frame information which is in turn recorded on the disk 1. Therefore, when noise or the like occurs in the information in the video, the detection of a matching every 5 fields is not successful.  
30 The video information remains as it is, and is still recorded on the disk.

In Figure 44, the  $n^{\text{th}}$  frame and the  $n+1^{\text{th}}$  frame in

the recorded information are recorded as film material while the  $n+2^{\text{th}}$  frame to the  $n+6^{\text{th}}$  frame are recorded as video information. The  $n+7^{\text{th}}$  frame and thereafter are recorded as film material. When such a disk is reproduced by the conventional image information reproduction apparatus, the  $n^{\text{th}}$  frame, the  $n+1^{\text{th}}$  frame, and the  $n+2^{\text{th}}$  frame are processed as film information. However, since a field repeat signal existing originally is not detected in the even field of the  $n+3^{\text{th}}$  frame, the progressive scanning conversion circuit 10 determines that the  $n+3^{\text{th}}$  frame is of video material and thereafter performs the progressive scanning conversion for up to the  $n+7^{\text{th}}$  frame as video material. The progressive scanning conversion circuit 10 starts performing the progressive scanning conversion again from the  $n+8^{\text{th}}$  frame as video material. Specifically, in a portion indicated by A in Figure 44, although the material is actually film, the progressive scanning conversion circuit 10 operates, recognizing the material as video. Thus, the progressive scanning conversion is not optimized.

In such an image signal reproduction apparatus, optimized progressive scanning conversion cannot be performed for an image signal of film material which has been partially recorded as a video signal of 60 fields per second as described above, causing the picture quality to be reduced. This is a drawback for the image signal reproduction apparatus. Accordingly, there is a demand for an image signal reproduction apparatus capable of applying progressive scanning conversion suitable for film material to an image signal of film material which has been partially recorded as a video signal of 60 fields per second.

Conventionally, image outputs of reproduction only

disks such as a digital versatile disk (hereinafter referred to as DVD) and CD, magneto-optical disks for recording using optical and magnetic means (hereinafter generically referred to as optical disks), satellite broadcast, 5 ground-based broadcast, and the like are commonly output by interlaced scanning so that the video outputs can be reproduced by an image receiver. Recently, image signal reproducing apparatuses for converting interlaced scanned image signals into progressive scanned signals are being 10 introduced as monitors and projectors compatible with multi-scanning, or monitors for computers is becoming widespread.

Figure 45 is a block diagram showing a configuration 15 of a conventional image signal reproducing apparatus. In Figure 45, reference numeral 201 denotes a disk on which either an image signal obtained by converting a film material image into an electrical signal or an image signal of which material is a video signal is recorded in an encoded and 20 modulated signal form suitable for pre-recording in advance. Reference numeral 202 denotes a pickup which converts the signal recorded on the disk 201 into an electrical signal. Reference numeral 203 denotes a disk rotating device which rotates the disk 201 at a certain revolutions-per-minute 25 suitable for the disk 201. Reference numeral 204 denotes an interlaced scanned video signal reproduction circuit which demodulates and decodes the image signal recorded on the disk 201, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 205 30 denotes an NTSC encoder which converts the interlaced scanned image signal into an NTSC video format and outputs the result. Reference numeral 206 denotes an interlaced scanned image output terminal through which the reproduced

interlaced scanned image is output. Reference numeral 207 denotes a progressive scanned image signal conversion circuit which converts an output of the interlaced scanned image signal reproduction circuit 204 into a progressive scanned image signal and outputs the result. Reference numeral 208 denotes a first memory which is capable of storing a field of image signals and which is used in the operation of the progressive scanned image signal conversion circuit 207. Reference numeral 209 denotes a color difference converter which converts an output of the progressive scanned image signal conversion circuit 207 into a progressive scanned color difference signal and outputs the result. Reference numeral 210 denotes a progressive scanning image output terminal through which the progressive scanned image signal is output to an image display apparatus not shown.

The operation of the conventional image signal reproduction apparatus thus constructed will be described with reference to Figures 46 through 50.

Figure 46 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the conventional image signal reproduction apparatus. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480. Both have a vertical frequency of 1/60 second. The number of horizontal

scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the  
5 progressive scanned image signal is about 31.5 KHz.

Figure 47 is a schematic signal diagram showing a structure of an image signal recorded in the disk 201 of the conventional image signal reproduction apparatus. As  
10 shown in Figure 47, the image signal recorded in the disk 201 has two forms. Specifically, Figure 47a) shows a film material. In this case, the original material is a film image composed of 24 frames of pictures per second. Each frame of the film image is compressed and recorded onto the  
15 disk 201 as an image of 720x480 dots. Figure 47b) shows a video material image. In this case, the original material is an interlaced scanned image composed of 30 frames/60 fields per second. Each frame is an image of 720x480 dots, but is interlaced, so that each field is an image of 720x240 dots. The field is compressed and recorded onto the  
20 disk 201.

When the material of the image signal recorded in the disk 201 is a film, 24 frames of images of 720x480 dots  
25 per second are recorded as recorded information. The interlaced scanned image signal reproduction circuit 204 reads the signal recorded on the disk 201 from an output of the pickup 202. As shown in Figure 47a-1), the film material images are recorded in the disk 201 in order of  
30 the frame numbers ..., n, n+1, n+2, n+3, ....

The film material signal thus recorded is modulated and converted into an interlaced scanned image and output

by the interlaced scanned signal reproduction circuit 204. This is because television monitors are most commonly used as an image display apparatus for home entertainment, and the display format is the interlaced scanning. Since the  
5 television monitor is designed to display a moving image of 30 frames/60 fields per second, the interlaced scanning video signal reproduction circuit 204 converts 24 frames of images per second into an interlaced scanned image of 30 frames/60 fields per second and outputs the result.

Specifically, the interlaced scanning video signal reproduction circuit 204 divides each frame of recorded information into two interlaced scanned field images, odd and even, as shown in the interlaced scanned reproduced image  
15 output in Figure 47a-2). The interlaced scanning video signal reproduction circuit 204 further displays the head field after the last field of each frame so that 24 frames of film images per second are converted into the interlaced scanned images of 30 frames/60 fields per second which are  
20 output. The NTSC encoder 205 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced, and outputs it through the interlaced scanned image output terminal 206. A television monitor (not shown) is connected to the interlaced scanned image output  
25 terminal 206 so that the user can see the film material image converted into the interlaced scanned image on the monitor.

Further, the interlaced scanned image signal reproduced circuit 204 inputs the interlaced scanned image  
30 signal to the progressive scanned image signal conversion circuit 207. The progressive scanned image signal conversion circuit 207 stores the head field of the progressive scanning conversion circuit input shown in

Figure 47a-2) in the first memory 7 and thereafter stores the second field in the first memory 7, and reads both information for each line at a double speed, thereby obtaining the progressive scanning conversion output shown in Figure 47a-3). The converted image signal is converted into an analog signal by the color difference converter 209, and the resultant analog signal is output through the progressive scanned image signal output terminal 210. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 210. The user can see the film material images restored to the progressive scanned image via the television monitor.

In the case when the material of image signals recorded in the disk 201 is video, an interlaced scanned image of 30 frames/60 fields per second is recorded as recorded information, each field having a 720x240 dots image. The interlaced scanned image signal reproduction circuit 204 reads the signal recorded in the disk 201 from an output of the pickup 202, and modulates the signal and outputs the modulated signal as the interlaced scanned image signal shown in Figure 47b-2) without alteration.

The NTSC encoder 205 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs it through the interlaced scanned image output terminal 206. A television monitor (not shown) is connected to the interlaced scanned image output terminal 206 so that the user can see the film material image converted into the interlaced scanned image via the monitor.

Further, the interlaced scanned image signal

reproduced circuit 204 inputs the interlaced scanned image signal to the progressive scanned image signal conversion circuit 207. In the case of the video material, the progressive scanning conversion circuit 207 generates a progressive scanned image signal using two pieces of field information, i.e., current field image information and the previous field. In this case, the progressive scanned image signal conversion circuit 207 also uses data for the previous field to interpolate in the vertical direction with respect to pixels having small movements between the current and previous fields of the progressive scanned conversion circuit output shown in Figure 47b-2). With respect to pixels having large movements between the current and previous fields, vertical interpolated data is generated from upper and lower pixel data in the same field to obtain a progressive scanning conversion circuit output shown in Figure 47b-3). The converted image signal is converted into an analog progressive scanned color difference signal by the color difference converter 209. The analog progressive scanned color difference signal is output through the progressive scanned image signal output terminal 210. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 210 so that the user can see the video material image converted into the progressive scanned image via the monitor.

Figure 48 is a schematic diagram showing the vertical frequency characteristics of materials for the conventional image signal reproduction apparatus. In the case of the video material to be interlaced scanned, each field has 240 lines, two fields having 480 lines. In the case of the film material, optical information recorded on



the original film is converted into electrical information of 480 lines of progressive scanned signals. Therefore, the vertical frequency characteristics are of a high band region indicated by the characteristics of the film material shown in Figure 48. The film material image is supposed to be reproduced by the interlaced scanned receiver. Bandwidth is limited in advance in order to avoid feedback interference. As indicated by the characteristics of the film material after removing interlace interference, the vertical frequency characteristics are reduced to the same level as that of the characteristics of the video material, at which level the film material image is recorded.

Figure 49 is a schematic diagram showing the vertical frequency characteristics of a progressive scanned image output for the conventional image signal reproduction apparatus. As shown in Figure 49, the vertical frequency characteristics after conversion into the progressive scanned image output are inferior to the characteristics of the original film material.

Figure 50 is a schematic diagram showing the frequency characteristics of visual appreciation of the interlaced scanned image and the progressive scanned image output of the conventional image signal reproduction apparatus. In general, a progressive scanning image monitor has twice as many the number of the horizontal scanning frequency as that of an interlaced scanning image monitor. Therefore, the electrical and optical frequency bands required to attain the same resolution needs to be doubled. The double number of scanning lines leads to a characteristic in which visual impression is low resolution. Therefore, comparing the interlaced scanned image signal

with the image signal obtained by converting the interlaced scanned image signal into the progressive scanned image signal, the latter image signal gives the user the impression that the frequency characteristics are poorer.  
5 Particularly, in the conventional image signal reproduction apparatus, the interlaced scanned image and the progressive scanned image are output at the same time. Therefore, both images can be easily compared with each other, so that a large difference between both images would be a large drawback for the image signal reproduction apparatus.  
10

In such an image signal reproduction apparatus, there is a problem in that, as described above, with respect to the film material image signal, the vertical frequency  
15 after the progressive scanning conversion has characteristics significantly inferior to the characteristics of the original film. There is also a problem in that there is the visual impression that the picture quality after the progressive scanning conversion has lower resolution than that of the picture quality after the interlaced scanning.  
20

Accordingly, there is a demand for introduction of an image signal reproduction apparatus capable of  
25 outputting a progressive scanned signal which has resolution close to that of the original film after the progressive scanning conversion and has resolution which is not visually degraded as compared with the interlaced scanned image.

30

Conventionally, image outputs of DVD, satellite broadcast, and the like are commonly output by interlaced scanning so that the video outputs can be reproduced by an

image receiver. Recently, image signal reproducing apparatuses for converting interlaced scanned image signals into progressive scanned signals are being introduced as monitors and projectors compatible with multi-scanning, or  
5 monitors for computers is becoming widespread.

Figure 51 is a block diagram showing a configuration of an image signal reproducing apparatus which is a conventional example of the technologies related to the  
10 present invention. The image signal reproducing apparatus includes an image signal and a determination flag for determining the aspect ratio of the image signal, and reproduces an information signal recorded on a disk. In Figure 51, reference numeral 301 denotes a disk on which  
15 an image signal and the determination flag indicating the aspect ratio of the image signal are recorded in an encoded and modulated signal form suitable for recording (or reproduction) in advance. Reference numeral 302 denotes a pickup which converts the signal recorded on the disk 301  
20 into an electrical signal. Reference numeral 303 denotes a disk rotating device which rotates the disk 301 at a certain revolutions-per-minute suitable for the disk 301. Reference numeral 304 denotes an interlaced scanned video signal reproduction circuit which demodulates and decodes  
25 the image signal recorded on the disk 301, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 305 denotes a material determination circuit which reads the determination flag recorded on the disk 301 from an output of the pickup 302.

30

Reference numeral 306 denotes a first aspect ratio conversion circuit which is controlled by the first control circuit 312 and which converts the aspect ratio of the input

image signal and outputs the result. Reference numeral 307 denotes an NTSC encoder which converts the interlaced scanned image signal into an NTSC video format and outputs the result. Reference numeral 308 denotes an interlaced scanned image output terminal through which the reproduced interlaced scanned image is output to a monitor (not shown) for the interlaced scanned image signal.

Reference numeral 309 denotes a progressive scanned image signal conversion circuit which converts an output of the first aspect ratio conversion circuit 306 into a progressive scanned image signal and outputs the result. Reference numeral 310 denotes a color difference converter which converts an output of the progressive scanned image signal conversion circuit 309 into an analog color difference signal and outputs the result. Reference numeral 311 denotes a progressive scanning image output terminal through which the progressive scanned image signal is output to a monitor (not shown) for the progressive scanning image.

Reference numeral 312 denotes a first control circuit which controls the first aspect ratio conversion circuit 306 using an output of the material determination circuit 305 and an output of a first aspect ratio setting section 313. Reference numeral 313 denotes the first aspect ratio setting section which is used by the user to set the aspect ratio of the receiver.

The operation of the conventional image signal reproduction apparatus thus constructed will be described with reference to Figures 52 through 60.

Figure 52 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in disk 301 in the conventional image signal reproduction apparatus. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480. Both have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

Figure 53 is a schematic signal diagram showing the aspect ratio of an image signal of the conventional image signal reproduction apparatus. As shown in Figure 53a), the image signal of image source recorded in the disk 301 has three forms. Specifically, Figure 53a)a-1) shows a material having information which fills a full screen of 4:3 (hereinafter referred to as a 4:3 full image). Figure 53a)a-2) shows a material having an image of 16:9 in the middle of the 4:3 screen, the upper and lower portions being shaded (hereinafter referred to as a 4:3 letterbox image). Figure 53a)a-3) shows a material having information which fills a full screen of 16:9 (hereinafter referred to as a 16:9 full image).

Figure 53b) shows the aspect ratio of the monitor for the interlaced scanned image signal. As shown in Figure 53b), there are two types of monitor for the interlaced scanned image signal, one type shown in Figure 53b)b-1) having an aspect ratio of 4:3 and the other shown in Figure 53b)b-2) having an aspect ratio of 16:9.

Figure 53c) shows the aspect ratio of the monitor for the progressive scanned image signal. As shown in Figure 53c), there are two types of monitor for the interlaced scanned image signal, one type shown in Figure 53c)c-1) having an aspect ratio of 4:3 and the other shown in Figure 53c)c-2) having an aspect ratio of 16:9.

The interlaced scanned image signal reproduction circuit 304 reads a signal recorded on the disk 301 from an output of the pickup 302, reproduces the interlaced scanned image signal, and outputs the result to the first aspect ratio conversion circuit 306. The material determination circuit 305 reads the determination flag from an output of the pickup 302, determines the type of the image signal, and outputs the result as the determination signal to the first control circuit 312.

The user sets the aspect ratio of a monitor via which the user intends to output the image signal, using the first aspect ratio setting section 313. The first control circuit 312 controls the first aspect ratio conversion circuit 306 using an output of the material determination circuit 305 and an output of the first aspect ratio setting section 313.

Figure 54 is a schematic diagram for explaining the

operation of the first aspect ratio conversion circuit 306 of the conventional image signal reproduction apparatus. Assuming that the monitor has an aspect ratio of 4:3, the first aspect ratio conversion circuit 306 has a function which compresses a material having an aspect ratio of 16:9 in the vertical direction. Specifically, in order to display the 16:9 material on the 4:3 monitor at the correct aspect ratio, 4 lines of information of an input image signal are subjected to a filtering process so that 3 lines of information are generated. Such a process is performed for the entire screen, so that the entire screen is compressed in the vertical direction. In this case, the aspect ratio is correctly converted for the 16:9 screen, but leaves blanks in the upper and lower portions. Such portions are rendered as black images. The aspect ratio conversion function can select a working or non-working state using the first control circuit 312. In the case of the non-working state, the first aspect ratio conversion circuit 306 outputs the input image signal without the aspect ratio conversion.

In Figure 51, the user sets the aspect ratio of the monitor for display to 4:3 or 16:9 using the first aspect ratio setting section 313. On the other hand, the material determination circuit 305 outputs the aspect ratio of the image source, i.e., whichever it is, the 4:3 full screen or the 4:3 letterbox screen or the 16:9 screen, to the first control circuit 312. The first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio conversion circuit 306 to be in the non-working state when the aspect ratio of the image source of the material determination circuit 305 is the 4:3 full image or the 4:3 letterbox image. The first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio

conversion circuit 306 to be in the non-working state when the material determination circuit 305 indicates that the aspect ratio of the image source is 16:9 and the first aspect ratio setting section outputs 16:9. Note that the first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio conversion circuit 306 to be in the working state when the material determination circuit 305 indicates that the aspect ratio of the image source is 16:9 and the first aspect ratio setting section outputs 4:3.

The NTSC encoder 307 converts an output of the first aspect ratio conversion circuit 306 to the NTSC video format. The interlaced scanned image output is output through the interlaced scanned image output terminal 308 to the interlaced scanned image monitor (not shown).

Next, the cases when the image source of the conventional image signal apparatus corresponds to the angle of view of the interlaced scanned image monitor image and when the image source of the conventional image signal apparatus corresponds to the angle of view of the progressive scanned image monitor image, will be described with respect to Figures 55 through 57 and Figures 58 through 60, respectively, for each of the 4:3 full screen, the 4:3 letterbox image, and the 16:9 image.

Figure 55 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 4:3 full image in the conventional image signal reproduction apparatus. As shown in Figure 55b-1, the correct aspect ratio is displayed on the 4:3 monitor. However, as shown



in Figure 55b-2, the 16:9 monitor does not display the correct aspect ratio, so that the displayed image is extended horizontally. On the other hand, the interlaced scanned image monitor includes a 4:3 output switch function since  
5 the standard aspect ratio of the conventional interlaced scanned image signal is 4:3. The interlaced scanned image monitor can display as shown in Figure 55b-3 at the correct 4:3 aspect ratio using the 4:3 output switch function.

10 Figure 56 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 4:3 letterbox image in the conventional image signal reproduction apparatus. As shown in Figure 56b-1, the  
15 correct aspect ratio is displayed on the 4:3 monitor. However, as shown in Figure 56b-2, the 16:9 monitor does not display the correct aspect ratio, so that the displayed image is extended horizontally. On the other hand, the interlaced scanned image monitor includes a 4:3 letterbox  
20 image output switch function since the standard aspect ratio of the conventional interlaced scanned image signal is 4:3. The interlaced scanned image monitor can display as shown in Figure 56b-3 at the correct 16:9 aspect ratio using the 4:3 output switch function.

25 Figure 57 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 16:9 image in the conventional image signal reproduction  
30 apparatus. As shown in Figure 57b-1, the aspect ratio with no change is not correctly displayed on the 4:3 monitor, so that the displayed image is extended vertically. However, if the user sets the fact that a monitor to be connected

is 16:9, to the first aspect ratio setting section, the first aspect ratio conversion circuit 306 is activated. The aspect ratio is converted so that the image is correctly displayed as shown in Figure 57b-4. In addition, as shown  
5 in Figure 57b-2, the 16:9 monitor displays the image at the 16:9 aspect ratio.

Specifically, in the conventional image signal reproduction apparatus, the interlaced scanned image  
10 monitor can display at the correct aspect ratio any combination of 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types image monitor, i.e., the 4:3 monitor and the 16:9 monitor.

15 An output of the first aspect ratio conversion circuit 306 is input to the progressive scanned image signal conversion circuit 309. The progressive scanned image signal conversion circuit 309 converts the input interlaced  
20 scanned image signal to the progressive scanned image signal, and outputs the result. The color difference converter 310 converts the progressive scanned image signal to a color difference image signal, and outputs the progressive scanned image output through the progressive scanned image  
25 output terminal 311 to the progressive scanned image monitor (not shown).

Figure 58 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned  
30 image monitor in the case of the image source having the 4:3 full image in the conventional image signal reproduction apparatus. As shown in Figure 58c-1, the aspect ratio is correctly displayed on the 4:3 monitor. However, as

indicated by c-2 in Figure 58, the aspect ratio with no change is not correctly displayed on the 16:9 monitor, so that the displayed image is extended horizontally. Here, the progressive scanned image 16:9 monitor is a monitor intended to receive a high-definition television signal, and does not include the 4:3 output mode. The 16:9 standard aspect ratio of the high-definition television signal is not displayed at the correct aspect.

Figure 59 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned image monitor in the case of the image source having the 4:3 letterbox image in the conventional image signal reproduction apparatus. As shown in Figure 59c-1, the aspect ratio is correctly displayed on the 4:3 monitor. However, as indicated by c-2 in Figure 59, the aspect ratio with no change is not correctly displayed on the 16:9 monitor, so that the displayed image is extended horizontally. As described above, the progressive scanned image 16:9 monitor is a monitor intended to receive a high-definition television signal, and does not include the 4:3 letterbox output mode. The 16:9 standard aspect ratio of the high-definition television signal is not displayed at the correct aspect.

Figure 60 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned image monitor in the case of the image source having the 16:9 image in the conventional image signal reproduction apparatus. As shown in Figure 60c-1, the aspect ratio with no change is not correctly displayed on the 4:3 monitor, so that the displayed image is extended vertically. However, if the user indicates the fact that a monitor to be connected

is 16:9, to the first aspect ratio setting section, the first aspect ratio conversion circuit 306 is activated. The aspect ratio is converted so that the image is correctly displayed as shown in Figure 60c-4. In addition, as shown  
5 in Figure 60c-3, the 16:9 monitor displays the image at the 16:9 aspect ratio.

In other words, in the conventional image signal reproduction apparatus, the progressive scanned image  
10 monitor cannot display at the correct aspect ratio a combination of the image sources of the 4:3 full image and the 4:3 letterbox image with the 16:9 image monitor.

As described above, in the conventional image signal reproduction apparatus, there is a problem in that the progressive scanned image monitor cannot display at the correct aspect ratio a combination of the image source of the 4:3 full image or the 4:3 letterbox image with the 16:9 image monitor. Accordingly, there is a demand for an image  
15 signal reproduction apparatus in which any combination of the 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types image monitor, i.e., the 4:3 monitor and the 16:9 monitor, can be displayed at the correct aspect ratio.  
20

25  
An object of the present invention is to provide an image signal reproduction apparatus which can perform a progressive scanning conversion process suitable for film material with respect to a film material image signal part of which is recorded as a video signal of 60 fields per second.  
30 This is achieved by determining the type of material of an image signal by determining whether a main image signal is a first type of image signal or a second type of image signal,

based on an output of a field difference detection circuit obtained from an interlaced scanned image signal and another interlaced scanned image signal 2 field before in addition to an output of a material determination circuit.

5

Another object of the present invention is to provide an image signal reproduction apparatus which can output a progressive scanned image with a resolution close to the original film and with less degradation of resolution compared with the interlaced scanned image even in visual appreciation, after subjecting the film material image signal to progressive scanning conversion.

10

Still another object of the present invention is to solve the above-described problems with the conventional technology and provide an image signal reproduction apparatus which can display an image at the correct aspect ratio in the case of any combination of image sources having different aspects and monitors having different aspects.

15

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#### DISCLOSURE OF THE INVENTION

An image signal reproduction apparatus according to the present invention is an image signal reproduction apparatus for reproducing a main image signal including either a first type of image signal obtained by converting a film material image into an electrical signal or a second type of image signal including a video signal as a material thereof, using a transfer information including the main image signal and a determination flag for determining whether the main image signal is the first type of image signal or the second type of image signal, the apparatus including: a first timing signal generation section for outputting a first timing signal indicating a field to be

25

30

repeatedly output in the case where the main image signal is the first type of image signal; a first material determination section for determining whether the main image signal is the first type of image signal or the second type of image signal, based on the determination flag; an interlaced scanned image signal reproduction section for converting the main image signal to an interlaced scanned image signal of 60 fields per second in response to an output of the first timing signal generation section when the first material determination section determines that the main image signal is the first type of image signal, and outputting the main image signal as it is when the first material determination section determines that the main image signal is the second type of image signal; a field memory for storing 2 fields of outputs of the interlaced scanned image signal reproduction section; a field difference detection section for detecting a difference between an output of the interlaced scanned image signal reproduction section and an output of the field memory; a second material determination section for determining whether the main image signal is the first type of image signal or the second type of image signal, based on an output of the first material determination section or on outputs of the first timing signal generation section and the field difference detection section; a second timing signal generation section for generating a second timing signal indicating a breakpoint between frames of the film material in the interlaced scanned image signal, based on an output of the field difference detection section when the second material detection section detects that the main image signal is the first type of image signal; and a progressive scanning conversion section for obtaining a progressive scanned image signal by synthesizing 2 fields of interlaced

scanned image signals of 60 fields per second in response to the second timing signal when a generation method of an insertion scanning signal is changed in response to an output of the second material determination section and the second  
5 material determination section determines that the main image signal is the first type of image signal, thereby achieving the above-described objects.

10 The second material determination section may determine that the main image signal is the first type of image signal when an output of the first material determination section or when a state of the timing generation section is in the state of the first type of image  
15 signal; even when the output of the first material determination section or the state of the timing generation section transitions from the state of the first type of image signal to the state of the second type of image signal, if the field difference detection section detects a field matching in a given period, the second material  
20 determination section may determine that the main image signal is the first type of image signal.

Even when the output of the first material determination section or the state of the timing generation  
25 section transitions from the state of the first type of image signal to the state of the second type of image signal, if the field difference detection section detects a field matching every 5 fields, the second material determination section may determine that the main image signal is the first  
30 type of image signal.

Another image signal reproduction apparatus according to the present invention is an image signal

reproduction apparatus for reproducing an information signal including any one of a first image signal obtained by converting a film material into an electrical signal or a second image signal whose material is a video signal, the  
5 apparatus including: an interlaced scanned image signal reproduction section for outputting the information signal as an interlaced scanned image signal of 60 fields per second; a progressive scanning conversion section for converting the information signal to a progressive scanned  
10 image signal; and a filtering section for changing a frequency characteristic of an output of the progressive scanning conversion circuit section.

An output of the interlaced scanned image signal reproduction section may be the input of the progressive  
15 scanning conversion section.

The filtering section may differentiate frequency characteristics between the first and second image signals.  
20

The frequency characteristic may be able to be changed by a setting made by the user.

Still another image signal reproduction apparatus  
25 of the present invention includes: an interlaced scanned image signal reproduction section for reproducing an image signal and an information signal including a determination signal determining the aspect ratio of the image signal as an interlaced scanned image signal of 60 fields per second;  
30 a flag determination section for reading the determination flag; a first aspect ratio conversion section for converting the aspect ratio of the interlaced scanned image signal; a first setting section for setting the aspect ratio of an



image receiver to which an output of the first aspect ratio conversion section is output; a first control section for controlling the aspect ratio of an output of the first aspect ratio conversion section based on outputs of the first setting section and the flag determination section; a progressive scanning conversion section for converting the output of the first aspect ratio conversion section to a progressive scanned image signal; a second aspect ratio conversion section for converting the image signal into an aspect ratio different from the first aspect ratio of the output of the first aspect ratio conversion section; a second setting section for setting the aspect ratio of an image receiver to which an output of the second aspect ratio conversion section is output; and a second control section for controlling the aspect ratio of an output of the second aspect ratio conversion section based on outputs of the second setting section and the flag determination section, thereby achieving the above-described objects.

The first aspect ratio conversion section may have functions of compressing an input image signal in a vertical direction, and causing a blank portion to be a black image; and the second aspect ratio conversion section may have functions of compressing an input image signal in a horizontal direction, and causing a blank portion to be a black image.

The first aspect ratio conversion section may have functions of compressing an input image signal in a vertical direction, and causing a blank portion as a result of the compression to be a black image; and the second aspect ratio conversion section may have either a function of compressing an input image signal in a horizontal direction, and causing

a blank portion as a result of the compression to be a black image, or a function of expanding the image in the vertical direction.

- 5           The determination flag may include at least two pieces of image information of an aspect ratio of 4:3, an aspect ratio of 16:9, and 16:9 image information in a screen having an aspect ratio of 4:3.

10       BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram showing a configuration of an image signal reproduction apparatus according to Example 1 of the present invention.

- 15           Figure 2 is a schematic diagram showing structures of an interlaced scanned image signal and a progressive scanned image signal of the image signal reproduction apparatus according to Example 1 of the present invention.

- 20           Figure 3 is a schematic signal diagram showing a structure of an image signal recorded in the disk 1 of the image signal reproduction apparatus according to Example 1 of the present invention.

- 25           Figure 4 is a schematic signal diagram showing a structure of a reproduced signal in a film material disk of the image signal reproduction apparatus according to Example 1 of the present invention.

- 30           Figure 5 is a schematic signal diagram showing an operation of a matching detection circuit in a film material disk of the image signal reproduction apparatus according to Example 1 of the present invention.

Figure 6 is a flowchart showing a determination method of a second material determination circuit of the image signal reproduction apparatus according to Example 1 of the present invention.

Figure 7 is a schematic signal diagram showing a structure of a reproduced signal in a video material disk of the image signal reproduction apparatus according to Example 1 of the present invention.

Figure 8 is a schematic signal diagram showing a reproduced signal in a disk, on part of which a video signal is recorded, in the image signal reproduction apparatus according to Example 1 of the present invention.

Figure 9 is a block diagram showing a configuration of an image signal reproduction apparatus according to Example 2 of the present invention.

Figure 10 is a schematic diagram showing structures of an interlaced scanned image signal and a progressive scanned image signal of the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 11 is a schematic signal diagram showing a structure of an image signal recorded in the disk 1 of the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 12 is a schematic signal diagram showing a structure of a reproduced signal in a film material disk of the image signal reproduction apparatus according to

Example 2 of the present invention.

Figure 13 is a schematic signal diagram showing an operation of a matching detection circuit in a film material disk of the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 14 is a flowchart showing a determination method of a second material determination circuit of the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 15 is a schematic signal diagram showing a structure of a reproduced signal in a video material disk of the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 16 is a schematic signal diagram showing a reproduced signal in a disk, on part of which a video signal is recorded, in the image signal reproduction apparatus according to Example 2 of the present invention.

Figure 17 is a block diagram showing a configuration of an exemplary image signal reproduction apparatus according to the present invention.

Figure 18 is a schematic diagram showing structures of an interlaced scanned image signal and a progressive scanned image signal of an exemplary image signal reproduction apparatus according to the present invention.

Figure 19 is a schematic diagram showing a structure of an image signal of an exemplary image signal reproduction

apparatus according to the present invention.

5       Figure 20 is a schematic diagram showing the vertical frequency characteristics of material of an exemplary image signal reproduction apparatus according to the present invention.

10       Figure 21 is a block diagram showing a structure of a spatial filter 11 of an exemplary image signal reproduction apparatus according to the present invention.

15       Figure 22 is a block diagram showing a structure of a vertical filter 15 of an exemplary image signal reproduction apparatus according to the present invention.

20       Figure 23 is a schematic diagram showing a characteristic of the vertical filter 15 of an exemplary image signal reproduction apparatus according to the present invention.

      Figure 24 is a block diagram showing a structure of a horizontal filter 16 of an exemplary image signal reproduction apparatus according to the present invention.

25       Figure 25 is a schematic diagram showing a characteristic of the horizontal filter 16 of an exemplary image signal reproduction apparatus according to the present invention.

30       Figure 26 is a schematic diagram showing an effect of the vertical filter 15 of an exemplary image signal reproduction apparatus according to the present invention.

Figure 27 is a schematic diagram showing visual appreciation-related characteristics of an interlaced scanned image and a progressive scanned image of an exemplary image signal reproduction apparatus according to the present invention.

Figure 28 is a block diagram showing a configuration of an exemplary image signal reproduction apparatus according to the present invention.

Figure 29 is a schematic diagram showing a structure of an image signal recorded in a disk of an exemplary image signal reproduction apparatus according to the present invention.

Figure 30 is a schematic diagram showing the aspect ratio of an image signal of an exemplary image signal reproduction apparatus according to the present invention.

Figure 31 is a schematic diagram showing the operation of a first aspect ratio conversion circuit of an exemplary image signal reproduction apparatus according to the present invention.

Figure 32 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3 full image, in an exemplary image signal reproduction apparatus according to the present invention.

Figure 33 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3

letterbox image, in an exemplary image signal reproduction apparatus according to the present invention.

5        Figure 34 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 16:9 image, in an exemplary image signal reproduction apparatus according to the present invention.

10        Figure 35 is a schematic diagram showing the operation of a second aspect ratio conversion circuit of an exemplary image signal reproduction apparatus according to the present invention.

15        Figure 36 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3 full image, in an exemplary image signal reproduction apparatus according to the present invention.

20        Figure 37 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3 letterbox image, in an exemplary image signal reproduction apparatus according to the present invention.

25        Figure 38 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 16:9 image, in an exemplary image signal reproduction apparatus according to the present invention.

30        Figure 39 is a block diagram showing a configuration

of a conventional image signal reproduction apparatus.

5       Figure 40 is a schematic diagram showing structures of an interlaced scanned image signal and a progressive scanned image signal of the conventional image signal reproduction apparatus.

10       Figure 41 is a schematic signal diagram showing a structure of an image signal recorded in the disk 1 of the conventional image signal reproduction apparatus.

15       Figure 42 is a schematic signal diagram showing a structure of a reproduced signal in a film material disk of the conventional image signal reproduction apparatus.

20       Figure 43 is a schematic signal diagram showing a structure of a reproduced signal in a video material disk of the conventional image signal reproduction apparatus.

25       Figure 44 is a schematic signal diagram showing a reproduced signal in a disk, on part of which a video signal is recorded, in the conventional image signal reproduction apparatus.

30       Figure 45 is a block diagram showing a configuration of a conventional image signal reproduction apparatus.

35       Figure 46 is a schematic diagram showing structures of an interlaced scanned image signal and a progressive scanned image signal of the conventional image signal reproduction apparatus.

Figure 47 is a schematic diagram showing a structure



of an image signal of the conventional image signal reproduction apparatus.

5 Figure 48 is a schematic diagram showing the vertical frequency characteristics of material of the conventional image signal reproduction apparatus.

10 Figure 49 is a schematic diagram showing the vertical frequency characteristics of a progressive scanned image output of the conventional image signal reproduction apparatus.

15 Figure 50 is a schematic diagram showing visual appreciation-related characteristics of an interlaced scanned image and a progressive scanned image of the conventional image signal reproduction apparatus.

20 Figure 51 is a block diagram showing a configuration of a conventional image signal reproduction apparatus.

Figure 52 is a schematic diagram showing a structure of an image signal recorded in a disk of the conventional image signal reproduction apparatus.

25 Figure 53 is a schematic diagram showing the aspect ratio of an image signal of the conventional image signal reproduction apparatus.

30 Figure 54 is a schematic diagram showing the operation of a first aspect ratio conversion circuit of the conventional image signal reproduction apparatus.

Figure 55 is a schematic diagram for explaining an

aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3 full image, in the conventional image signal reproduction apparatus.

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Figure 56 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 4:3 letterbox image, in the conventional image signal reproduction apparatus.

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Figure 57 is a schematic diagram for explaining an aspect ratio of an image displayed on an interlaced scanned image monitor in the case of an image source of the 16:9 image, in the conventional image signal reproduction apparatus.

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Figure 58 is a schematic diagram for explaining an aspect ratio of an image displayed on a progressive scanned image monitor in the case of an image source of the 4:3 full image, in the conventional image signal reproduction apparatus.

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Figure 59 is a schematic diagram for explaining an aspect ratio of an image displayed on a progressive scanned image monitor in the case of an image source of the 4:3 letterbox image, in the conventional image signal reproduction apparatus.

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Figure 60 is a schematic diagram for explaining an aspect ratio of an image displayed on a progressive scanned image monitor in the case of an image source of the 16:9 image, in the conventional image signal reproduction

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apparatus.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, examples of the present invention will  
5 be described with reference to the drawings.

##### (Example 1)

Figure 1 is a block diagram showing a configuration  
of an image signal reproduction apparatus according to  
10 Example 1 of the present invention. In Figure 1, reference  
numeral 1 denotes a disk on which a main image signal and  
a determination flag are recorded in an encoded and modulated  
signal form suitable for recording in advance. The main  
signal is either an image signal obtained by converting a  
15 film material into an electrical signal or an image signal  
of which material is a video signal. The determination flag  
shows whether the main image signal is of film material or  
video material. Reference numeral 2 denotes a pickup which  
converts the signal recorded on the disk 1 into an electrical  
20 signal. Reference numeral 3 denotes a disk rotating device  
which rotates the disk 1 at a certain revolution-per-minute  
suitable for the disk 1. Reference numeral 4 denotes an  
interlaced scanned video signal reproduction circuit which  
demodulates and decodes the main image signal recorded on  
25 the disk 1, and outputs the resultant signal as an interlaced  
scanned image signal. Reference numeral 5 denotes a first  
memory which functions as a buffer memory when the interlaced  
scanned image signal is reproduced. Reference numeral 6  
denotes an NTSC encoder which converts the interlaced  
30 scanned image signal into an NTSC video format and outputs  
the result. Reference numeral 7 denotes an interlaced  
scanned image output terminal through which the reproduced  
interlaced scanned image output is output. Reference

numeral 8 denotes a first material determination circuit which reads the determination flag recorded on the disk 1 from an output of the pickup 2. Reference numeral 9 denotes a field repeat signal generating circuit which generates  
5 a field repeat signal when the interlaced scanned image signal reproduction circuit 4 converts the main image signal into an interlaced scanned image signal in the case when the main image signal is of film material. Reference numeral 11 denotes a second memory which is capable of  
10 storing a field of image signal and which is used in the operation of a progressive scanning conversion circuit 17 (described later). Reference numeral 12 denotes a D/A converter which converts an output of the progressive scanning conversion circuit 17 into an analog value and  
15 outputs the result. Reference numeral 13 denotes a progressive scanning image output terminal through which the progressive scanned image signal is output to an image display apparatus (not shown). Reference numeral 14 denotes a second material determination circuit which  
20 determines the type of an image signal recorded on the disk 1 based on an output of the field repeat signal generation circuit 9 and an output of a second matching detection circuit 15, thereby controlling the progressive scanning conversion circuit 17. Reference numeral 15 denotes the  
25 matching detection circuit which compares an output of the interlaced scanned image signal reproduction circuit 4 and an output of a third memory 16. Reference numeral 16 denotes the third memory which delays an output of the interlaced scanned image signal reproduction circuit 4 by  
30 2 fields, and outputs the delayed output. Reference numeral 17 denotes the progressive scanning conversion circuit which converts an output of the interlaced scanned image signal reproduction circuit 4 to a progressive

scanned image signal, and outputs the result. Reference numeral 18 denotes a repeat periodic signal generation circuit which provides a field repeat signal required for progressive scanning conversion in the progressive scanning conversion circuit 17 in response to an output of the second matching detection circuit 15.

The operation of the image signal reproduction apparatus thus constructed of Example 1 of the present invention will be described.

Figure 2 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the image signal reproduction apparatus according to Example 1 of the present invention. As described using Figure 18 in the BACKGROUND ART section, in the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field is buried between the other fields in the vertical direction, vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480.

Both signals have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

Figure 3 is a schematic signal diagram showing a structure of the image signal recorded in the disk 1 of the image signal reproduction apparatus according to Example 1 of the present invention. As shown in Figure 3, the image signal recorded in the disk 1 has two forms. Specifically, Figure 3a) shows a film material. In this case, the original material is a film image composed of 24 frames of pictures per second. Each frame of the film image is compressed and recorded onto the disk 1 as an image of 720x480 dots. Figure 3b) shows a video material image. In this case, the original material is an interlaced scanned image composed of 30 frames/60 fields per second. Each frame is an image of 720x480 dots, but interlaced, so that each field is an image of 720x240 dots. The field is compressed and recorded onto the disk 1. As shown in Figure 3, the determination flag, which shows whether the main image signal is of film material or video material, is recorded on the disk 1 along with the main video signal.

Figure 4 is a schematic signal diagram showing a reproduced signal from a film material disk of Example 1 of the present invention.

When the material of the image signal recorded in the disk 1 is a film, 24 frames of images of 720x480 dots per second are recorded. The interlaced scanned image signal reproduction circuit 4 reads the signal recorded on the disk 1 from an output of the pickup 2. The first material determination circuit 8 reads the determination flag from an output of the pickup 2 and determines the type of the main image signal, and outputs the result to the interlaced scanned image signal reproduction circuit 4 and the field repeat signal generation circuit 9. Based on an

output of the first material determination circuit 8, the interlaced scanned reproduction circuit 4 recognizes that the main image signal recorded in the disk 1 is of film material. As shown in Figure 4, the film material images are recorded in the disk 1 in order of the frame numbers ..., n, n+1, n+2, n+3, ... . The film material signal thus recorded is converted into an interlaced scanned image and is output by the interlaced scanned signal reproduction circuit 4. This is because television monitors are commonly used as an image display apparatus for home entertainment, and the display format is the interlaced scanning. Since the television monitor is designed to display a moving image of 30 frames/60 fields per second, the interlaced scanning video signal reproduction circuit 4 converts 24 frames of images per second into 30 frames/60 fields per second and outputs the result. The interlaced scanning video signal reproduction circuit 4 divides each frame of recorded information into two interlaced scanned field images, odd and even, as shown in the interlaced scanned reproduced image signal in Figure 4. The interlaced scanning video signal reproduction circuit 4 further displays the head field after the last field of each frame in response to the field repeat signal repeated every 5 fields output from the field repeat signal generation circuit 9 so that 24 frames of film images per second are converted into the interlaced scanned images of 30 frames/60 fields per second which are output. The first memory 5 functions as a buffer memory when the interlaced scanning video signal reproduction circuit 4 reproduces an image.

The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced

scanned image output terminal 7. A television monitor (not shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the interlaced scanned image on the monitor.

5

Further, the interlaced scanned image signal reproduced circuit 4 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 17, the matching detection circuit 15, and the third memory 16.

10 The third memory 16 delays the input interlaced scanned image signal by 2 fields, and outputs the result to the matching detection circuit 15.

Figure 5 is a schematic signal diagram showing an operation of the matching detection circuit in a film material disk of the image signal reproduction apparatus according to Example 1 of the present invention.

In the matching detection circuit 15, it is determined whether the material of an image signal is a film material or video material. Specifically, if the input image signal is obtained by converting film to video, a head field is repeated after a last field for each frame. Therefore, the same field appears once every 5 fields. Accordingly, the matching detection circuit 15 detects that the number of pixels, which satisfies that the data difference in each pixel of each field between an output of the third memory 16 and an output of the interlaced scanned image signal generation circuit 4 is smaller than or equal to a predetermined threshold, is greater than or equal to a certain value. If the matching detection circuit 15 thus detects the matching of fields, the matching detection is provided to the field comparison information



shown in Figure 5. In this way, the matching detection is "1" every 5 fields. Therefore, when the matching detection circuit 15 detects a change in the field comparison information every 5 fields, the matching detection circuit 15 determines that the material of the image signal is of film.

Figure 6 is a flowchart showing a determination method of the second material determination circuit according to Example 1 of the present invention.

As shown in Figure 6, the second material determination circuit 14 determines whether the material of an image signal is a film material or video material, based on an output of the field repeat signal generation circuit 9 and an output of the matching detection circuit 15. Specifically, when the field repeat signal is generated, it is determined that the material of the image signal is of film material. Even after transition from the state where the field repeat signal is generated to the state where the field repeat signal is not generated, if the matching detection circuit determines that the material of the image signal is the film material, the second material determination circuit 14 determines that the material is the film material.

The repeat periodic signal generation circuit 18 generates a repeat periodic signal shown in Figure 4, based on the field comparison information every 5 fields detected by the matching detection circuit 15. The field comparison information only indicates how much information a current field matches a second field before the current field. The matching detection depends on the threshold used for

determining whether matching or not and the image information, and therefore the matching may not be detected. The repeat periodic signal generation circuit 18 also functions as a flywheel circuit so that the repeat  
5 information of the 5 field period is generated when the field comparison information is not obtained.

When the second material determination circuit 14 determines that the main image is of film material, the  
10 progressive scanning conversion circuit 17 performs the progressive scanning conversion in response to the repeat periodic signal generated by the repeat periodic signal generation circuit 18. Specifically, in the case of film material, for each frame of each material, an original image  
15 of 720x480 dots is divided into 2 fields of 720x240 dots, which may be synthesized again. Therefore, the progressive scanning conversion circuit 17 can detect the timing of switching of the frames of the film signal which is the material of an input digital image signal, using the repeat  
20 periodic signal shown in Figure 4. In response to the repeat periodic signal, the progressive scanning conversion circuit 17 stores the head field of the progressive scanning conversion circuit input shown in Figure 4 in the second memory 11 and the second field in the second memory 11, and  
25 reads out both information on a line-by-line basis at a double speed, thereby obtaining the progressive scanning conversion circuit output shown in Figure 4. The converted image signal is converted into an analog signal by the D/A converter 12. The resultant analog signal is output  
30 through the progressive scanned image signal output terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13. The

user can see the film material images restored to the progressive scanned image via the television monitor.

Figure 7 is a schematic signal diagram showing a reproduced signal of the video material disk of Example 1 of the present invention.

In the case when the material of image signals recorded in the disk 1 is video material, an interlaced scanned image of 30 frames/60 fields per second is recorded as recorded information, each field having a 720x240 dots image as shown in Figure 7. The interlaced scanned image signal reproduction circuit 4 reads the signal recorded in the disk 1 from an output of the pickup 2. The first material determination circuit 8 reads the determination flag from the output of the pickup 2 and determines the type of the main image signal, and outputs the determination flag as the determination signal to the interlaced scanned image signal reproduction circuit 4 and the field repeat signal generation circuit 9. As shown in Figure 7, the video material images are recorded in the disk 1 in order of the frame numbers ..., m, m+1, m+2, m+3, m+4, .... The interlaced scanned image signal reproduction circuit 4 outputs the video material signal thus recorded as the interlaced scanned image signal shown in Figure 7 without alteration. The first memory 5 functions as a buffer memory when the interlaced scanned image signal reproduction circuit 4 reproduces an image.

The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced scanned image output terminal 7. A television monitor (not

shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the interlaced scanned image via the monitor.

5           The matching detection circuit 15 determines whether the material of an image signal is of film material or video material. Specifically, the same field does not appear once every 5 fields when the input image signal is of video material. Therefore, the matching detection  
10 circuit 15 determines that the interlaced scanned image is not a film material by detecting no such periodicity.

          The second material determination circuit 14 determines whether the material of the image signal is of  
15 film material or video material, based on an output of the field repeat signal generation circuit 9 and an output of the matching detection circuit 15. The second material determination circuit 14 shown in Figure 6 determines that the image signal is of video signal when the field repeat  
20 signal is not generated and the matching detection circuit 15 does not determine that the image signal is of film material. The interlaced scanned image signal reproduction circuit 4 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 17.  
25 The progressive scanning conversion circuit 17 recognizes that the input digital image signal is of video signal, based on an output of the second material determination circuit 14. Accordingly, the progressive scanning conversion circuit 17 performs the progressive scanning conversion  
30 while the main image signal is regarded as the video material. Specifically, in the case of the video material, the progressive scanning conversion circuit 17 generates a progressive scanned image signal using two pieces of field

information, i.e., current field image information and the previous field information. In this case, the progressive scanning conversion circuit 17 also uses data for the previous field to interpolate in the vertical direction with respect to pixels having small movements between the current and previous fields of the progressive scanned conversion circuit input shown in Figure 7. With respect to pixels having large movements between the current and previous fields, vertical interpolated data is generated from upper and lower pixel data in the same field to obtain a progressive scanning conversion circuit output shown in Figure 7. The converted image signal is converted into an analog signal by the D/A converter 12. The analog signal is output through the progressive scanned image signal output terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13 so that the user can see the video material image converted into the progressive scanned image via the monitor.

Figure 8 is a schematic signal diagram showing a reproduced signal from a disk, which is a film material disk partially including a recorded video signal, of the image signal reproduction apparatus of Example 1 of the present invention.

Even when the signal source is of film material, part of the signal source may be recorded as a video signal. This happens as follows. A film material may initially be recorded in a video or the like before being recorded on the disk 1. When the material as video is restored to 24-frame information again, part of the material remains as video and is recorded in the disk 1. Specifically, when

information to be recorded in the disk 1 is generated, a breakpoint between the frames of the original picture in the recorded video is found by detecting a match every 5 fields in the material recorded in the video of 60 fields, and the video is restored to 24-frame information which is in turn recorded on the disk 1. Therefore, when noise or the like occurs in the information in the video, the detection of a match every 5 fields is not successful. The video information remains as it is, and is still recorded on the disk.

In Figure 8, the  $n^{\text{th}}$  frame and the  $n+1^{\text{th}}$  frame in the recorded information are recorded as film material while the  $n+2^{\text{th}}$  frame to the  $n+6^{\text{th}}$  frame are recorded as video information. The  $n+7^{\text{th}}$  frame and thereafter are recorded as film material. When such a disk is reproduced by the image information reproduction apparatus of Example 1 of the present invention, the  $n^{\text{th}}$  frame, the  $n+1^{\text{th}}$  frame, and the  $n+2^{\text{th}}$  frame are processed as film information. However, a field repeat signal existing originally is not detected in the even field of the  $n+3^{\text{th}}$  frame. Since the original image signal is obtained by converting the film material to 30 frames/60 fields, the feature that the matching of the field information occurs once every 5 fields is held.

The matching detection circuit 15 counts the number of pixels, which satisfies that the data difference in each pixel of each field between an output of the third memory and an output of the interlaced scanned image signal generation circuit 4 is smaller than or equal to a predetermined threshold, and detects the matching of fields if the count value is greater than or equal to a certain value. Such matching detection is indicated by the field

comparison information shown in Figure 8. In this way, the matching detection is "1" every 5 fields. Therefore, when the matching detection circuit 15 detects a change in the field comparison information every 5 fields, the matching  
5 detection circuit 15 determines that the material of the image signal is of film.

The second material determination circuit 14 determines whether the material of an image signal is a film material or video material, based on an output of the field repeat signal generation circuit 9 and an output of the matching detection circuit 15. As shown in Figure 6, even after transition from the state where the field repeat signal is generated to the state where the field repeat signal is  
10 not generated, if the matching detection circuit determines that the material of the image signal is the film material, the second material determination circuit 14 determines that the material is the film material. Therefore, the second material determination circuit 19 determines that  
15 the  $n+2^{\text{th}}$  frame through the  $n+6^{\text{th}}$  frame are of film material in Figure 8. When the second material determination circuit 14 determines that the main image is of film material, the progressive scanning conversion circuit 17 performs the  
20 progressive scanning conversion in response to the repeat periodic signal generated by the repeat periodic signal generation circuit 18. Specifically, in the case of film material, for each frame of each material, an original image of  $720 \times 480$  dots is divided into 2 fields of  $720 \times 240$  dots, which may be synthesized again. Therefore, the progressive  
25 scanning conversion circuit 17 can detect the timing of switching of the frames of the film signal which is the material of an input digital image signal, using the repeat periodic signal shown in Figure 8. In response to the  
30

repeat periodic signal, the progressive scanning conversion circuit 17 stores the head field of the progressive scanning conversion circuit input shown in Figure 8 in the second memory 11 and the second field in the second memory 11, and  
5 reads out both information on a line-by-line basis at a double speed, thereby obtaining the progressive scanning conversion circuit output. The converted image signal is converted into an analog signal by the D/A converter 12. The resultant analog signal is output through the  
10 progressive scanned image signal output terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13. The user can see the film material images restored to the progressive scanned image  
15 via the television monitor.

Therefore, the image signal reproduction apparatus according to Example 1 of the present invention can apply the progressive scanning conversion suitable for film  
20 material to an image signal of film material which has been partially recorded as a video signal of 60 fields per second.

(Example 2)

Figure 9 is a block diagram showing a configuration  
25 of an image signal reproduction apparatus according to Example 2 of the present invention. In Figure 9, reference numeral 1 denotes a disk on which a main image signal and a determination flag are recorded in an encoded and modulated signal form suitable for recording in advance. The main  
30 signal is either an image signal obtained by converting a film material into an electrical signal or an image signal of which material is a video signal. The determination flag shows whether the main image signal is of film material or



video material. Reference numeral 2 denotes a pickup which converts the signal recorded on the disk 1 into an electrical signal. Reference numeral 3 denotes a disk rotating device which rotates the disk 1 at a certain revolution-per-minute  
5 suitable for the disk 1. Reference numeral 4 denotes an interlaced scanned video signal reproduction circuit which demodulates and decodes the main image signal recorded on the disk 1, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 5 denotes a first  
10 memory which functions as a buffer memory when the interlaced scanned image signal is reproduced. Reference numeral 6 denotes an NTSC encoder which converts the interlaced scanned image signal into an NTSC video format and outputs the result. Reference numeral 7 denotes an interlaced  
15 scanned image output terminal through which the reproduced interlaced scanned image output is output. Reference numeral 8 denotes a first material determination circuit which reads the determination flag recorded on the disk 1 from an output of the pickup 2. Reference numeral 9 denotes  
20 a field repeat signal generating circuit which generates a field repeat signal when the interlaced scanned image signal reproduction circuit 4 converts the main image signal into an interlaced scanned image signal in the case when the main image signal is of film material. Reference  
25 numeral 11 denotes a second memory which is capable of storing a field of image signal and which is used in the operation of a progressive scanning conversion circuit 17. Reference numeral 12 denotes a D/A converter which converts an output of the progressive scanning conversion circuit 10  
30 into an analog value and outputs the result. Reference numeral 13 denotes a progressive scanning image output terminal through which the progressive scanned image signal is output to an image display apparatus (not shown).

Reference numeral 19 denotes a second material determination circuit which determines the type of an image signal recorded on the disk 1 based on an output of the first material determination circuit 8 and an output of a second matching detection circuit 15, thereby controlling the progressive scanning conversion circuit 17. Reference numeral 15 denotes the matching detection circuit which compares an output of the interlaced scanned image signal reproduction circuit 4 and an output of a third memory 16. Reference numeral 16 denotes the third memory which delays an output of the interlaced scanned conversion circuit 4 by 2 fields, and outputs the delayed output. Reference numeral 17 denotes the progressive scanning conversion circuit which converts an output of the interlaced scanned conversion circuit 4 to a progressive scanned image signal, and outputs the result. Reference numeral 18 denotes a repeat periodic signal generation circuit which provides a field repeat signal required for progressive scanning conversion in the progressive scanning conversion circuit 17 in response to an output of the second matching detection circuit 15.

The operation of the image signal reproduction apparatus thus constructed of Example 2 of the present invention will be described.

Figure 10 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the image signal reproduction apparatus according to Example 2 of the present invention, which is similar to Figures 2 and 40. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The

number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the  
5 number of pixels in the vertical direction is 480.

Both signals have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that  
10 of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

15 Figure 11 is a schematic signal diagram showing a structure of the image signal recorded in the disk 1 of the image signal reproduction apparatus according to Example 2 of the present invention. As shown in Figure 11, the image signal recorded in the disk 1 has two forms. Specifically,  
20 Figure 11a) shows a film material. In this case, the original material is a film image composed of 24 frames of pictures per second. Each frame of the film image is compressed and recorded onto the disk 1 as an image of 720x480 dots. Figure 11b) shows a video material image. In  
25 this case, the original material is an interlaced scanned image composed of 30 frames/60 fields per second. Each frame is an image of 720x480 dots, but interlaced, so that each field is an image of 720x240 dots. The field is compressed and recorded onto the disk 1. As shown in  
30 Figure 11, the determination flag which shows whether the main image signal is of film material or video material, is recorded on the disk 1 along with the main video signal.

Figure 12 is a schematic signal diagram showing a reproduced signal from a film material disk of Example 2 of the present invention.

5           When the material of the image signal recorded in  
the disk 1 is a film, 24 frames of images of 720×480 dots  
per second are recorded as shown in Figure 12. The  
interlaced scanned image signal reproduction circuit 4  
reads the signal recorded on the disk 1 from an output of  
10 the pickup 2. The first material determination circuit 8  
reads the determination flag from an output of the pickup 2  
and determines the type of the main image signal, and outputs  
the result to the interlaced scanned image signal  
reproduction circuit 4, the field repeat signal generation  
15 circuit 9, and the second material determination circuit 19.  
Based on an output of the first material determination  
circuit 8, the interlaced scanned reproduction circuit 4  
recognizes that the main image signal recorded in the disk 1  
is of film material. As shown in Figure 12, the film  
20 material images are recorded in the disk 1 in order of the  
frame numbers ..., n, n+1, n+2, n+3, .... The film material  
signal thus recorded is converted into an interlaced scanned  
image and output by the interlaced scanned signal  
reproduction circuit 4. This is because television  
25 monitors are commonly used as an image display apparatus  
for home entertainment, and the display format is the  
interlaced scanning. Since the television monitor is  
designed to display a moving image of 30 frames/60 fields  
per second, the interlaced scanning video signal  
30 reproduction circuit 4 converts 24 frames of images per  
second into 30 frames/60 fields per second and outputs the  
result. The interlaced scanning video signal reproduction  
circuit 4 divides each frame of recorded information into

two interlaced scanned field images, odd and even, as shown in the interlaced scanned reproduced image signal in Figure 12. The interlaced scanning video signal reproduction circuit 4 further displays the head field after the last field of each frame in response to the field repeat signal repeated every 5 fields output from the field repeat signal generation circuit 9 so that 24 frames of film images per second are converted into the interlaced scanned images of 30 frames/60 fields per second which are output. The first memory 5 functions as a buffer memory when the interlaced scanning video signal reproduction circuit 4 reproduces an image.

The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced scanned image output terminal 7. A television monitor (not shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the interlaced scanned image on the monitor.

Further, the interlaced scanned image signal reproduced circuit 4 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 17, the matching detection circuit 15, and the third memory 16. The third memory 16 delays the input interlaced scanned image signal by 2 fields, and outputs the result to the matching detection circuit 15.

Figure 13 is a schematic signal diagram showing an operation of the matching detection circuit in a film material disk according to Example 2 of the present invention.

In the matching detection circuit 15, it is determined whether the material of an image signal is a film material or video material. Specifically, if the input  
5 image signal is obtained by converting film to video, a head field is repeated after a last field for each frame. Therefore, the same field appears once every 5 fields. Accordingly, the matching detection circuit 15 detects that the number of pixels, which satisfies that the data  
10 difference in each pixel of each field between an output of the third memory 16 and an output of the interlaced scanned image signal generation circuit 4 is less than or equal to a predetermined threshold, is greater than or equal to a certain value. If the matching detection circuit 15  
15 thus detects the matching of fields, the matching detection is provided to the field comparison information shown in Figure 13. In this way, the matching detection is "1" every 5 fields. Therefore, when the matching detection circuit 15 detects a change in the field comparison  
20 information every 5 fields, the matching detection circuit 15 determines that the material of the image signal is of film.

Figure 14 is a flowchart showing a determination  
25 method of the second material determination circuit according to Example 2 of the present invention.

As shown in Figure 14, the second material  
30 determination circuit 19 determines whether the material of an image signal is a film material or video material, based on an output of the first material determination circuit 8 and an output of the matching detection circuit 15. Specifically, when the field repeat signal is generated,

it is determined that the material of the image signal is of film material. Even after the first material determination circuit 8 transitions from the state where it is determined that the image signal is of film material to the state where it is determined the image signal is of video material, if the matching detection circuit determines that the material of the image signal is the film material, the second material determination circuit 19 determines that the material is the film material.

The repeat periodic signal generation circuit 18 generates a repeat periodic signal shown in Figure 12, based on the field comparison information every 5 fields detected by the matching detection circuit 15. The field comparison information only indicates how much information a current field matches a second field before the current field. The matching detection depends on the threshold used for determining whether matching or not and the image information, and therefore the matching may not be detected. The repeat periodic signal generation circuit 18 also functions as a flywheel circuit so that the repeat information of the 5 field period is generated when the field comparison information is not obtained.

When the second material determination circuit 19 determines that the main image is of film material, the progressive scanning conversion circuit 17 performs the progressive scanning conversion in response to the repeat periodic signal generated by the repeat periodic signal generation circuit 18. Specifically, in the case of film material, for each frame of each material, an original image of 720x480 dots is divided into 2 fields of 720x240 dots, which may be synthesized again. Therefore, the progressive

scanning conversion circuit 17 can detect the timing of switching of the frames of the film signal which is the material of an input digital image signal, using the repeat periodic signal shown in Figure 12. In response to the repeat periodic signal, the progressive scanning conversion circuit 17 stores the head field of the progressive scanning conversion circuit input shown in Figure 12 in the second memory 11 and the second field in the second memory 11, and reads out both information on a line-by-line basis at a double speed, thereby obtaining the progressive scanning conversion circuit output. The converted image signal is converted into an analog signal by the D/A converter 12. The resultant analog signal is output through the progressive scanned image signal output terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13. The user can see the film material images restored to the progressive scanned image via the television monitor.

Figure 15 is a schematic signal diagram showing a reproduced signal of the video material disk of Example 1 of the present invention.

In the case when the material of image signals recorded in the disk 1 is a video material, an interlaced scanned image of 30 frames/60 fields per second is recorded as recorded information, each field having a 720x240 dots image as shown in Figure 15. The interlaced scanned image signal reproduction circuit 4 reads the signal recorded in the disk 1 from an output of the pickup 2. The first material determination circuit 8 reads the determination flag from the output of the pickup 2 and determines the type



of the main image signal, and outputs the determination flag as the determination signal to the interlaced scanned image signal reproduction circuit 4 and the field repeat signal generation circuit 9. As shown in Figure 15, the video material images are recorded in the disk 1 in order of the frame numbers ..., m, m+1, m+2, m+3, m+4, ... . The interlaced scanned image signal reproduction circuit 4 outputs the video material signal thus recorded as the interlaced scanned image signal shown in Figure 15 without alteration. The first memory 5 functions as a buffer memory when the interlaced scanned image signal reproduction circuit 4 reproduces an image.

The NTSC encoder 6 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs the result through the interlaced scanned image output terminal 7. A television monitor (not shown) is connected to the interlaced scanned image output terminal 7 so that the user can see the film material image converted into the interlaced scanned image via the monitor.

The matching detection circuit 15 determines whether the material of an image signal is of film material or video material. Specifically, the same field does not appear once every 5 fields when the input image signal is of video material. Therefore, the matching detection circuit 15 determines that the interlaced scanned image is not of film material, based on the fact that there does not exist synchronicity.

The second material determination circuit 19 determines whether the material of the image signal is of film material or video material, based on an output of the

first material determination circuit 8 and an output of the matching detection circuit 15. The second material determination circuit 19 shown in Figure 14 determines that the image signal is of video signal when the first material

5 determination circuit 8 determines that the image signal is of video material and the matching detection circuit 15 determines that the image signal is of film material. The interlaced scanned image signal reproduction circuit 4

10 inputs the interlaced scanned image signal to the progressive scanning conversion circuit 17. The progressive scanning conversion circuit 17 recognizes that the input digital image signal is of video signal, based on an output of the second material determination circuit 19. Accordingly, the progressive scanning conversion

15 circuit 17 performs the progressive scanning conversion while the main image signal is regarded as the video material. Specifically, in the case of the video material, the progressive scanning conversion circuit 17 generates a progressive scanned image signal using two pieces of field

20 information, i.e., current field image information and the previous field information. In this case, the progressive scanning conversion circuit 17 also uses data for the previous field to interpolate in the vertical direction with respect to pixels having small movements between the current

25 and previous fields of the progressive scanned conversion circuit input shown in Figure 15. With respect to pixels having large movements between the current and previous fields, vertical interpolated data is generated from upper and lower pixel data in the same field to obtain a progressive

30 scanning conversion circuit output shown in Figure 15. The converted image signal is converted into an analog signal by the D/A converter 12. The analog signal is output through the progressive scanned image signal output

terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13 so that the user can see the video material image converted into the progressive scanned image via the monitor.

Figure 16 is a schematic signal diagram showing a reproduced signal from a disk, which is a film material disk partially including a recorded video signal, of the image signal reproduction apparatus of Example 2 of the present invention.

Even when the signal source is of film material, part of the signal source may be recorded as a video signal. This happens as follows. A film material may initially be recorded in a video or the like before being recorded on the disk 1. When the material as video is restored to 24-frame information again, part of the material remains as video and is recorded in the disk 1. Specifically, when information to be recorded in the disk 1 is generated, a breakpoint between the frames of the original picture in the recorded video is found by detecting a match every 5 fields in the material recorded in the video of 60 fields, and the video is restored to 24-frame information which is in turn recorded on the disk 1. Therefore, when noise or the like occurs in the information in the video, the detection of a match every 5 fields is not successful. The video information remains as it is, and is still recorded on the disk.

In Figure 16, the  $n^{\text{th}}$  frame and the  $n+1^{\text{th}}$  frame in the recorded information are recorded as film material while the  $n+2^{\text{th}}$  frame to the  $n+6^{\text{th}}$  frame are recorded as video

information. The  $n+7^{\text{th}}$  frame and thereafter are recorded as film material.

When such a disk is reproduced by the image  
5 information reproduction apparatus of Example 2 of the  
present invention, the  $n^{\text{th}}$  frame, the  $n+1^{\text{th}}$  frame, and the  
 $n+2^{\text{th}}$  frame are processed as film information. However, a  
field repeat signal to exist originally is not detected in  
the even field of the  $n+3^{\text{th}}$  frame. Since the original image  
10 signal is obtained by converting the film material to 30  
frames/60 fields, the feature that the matching of the field  
information occurs once every 5 field is held.

The matching detection circuit 15 counts the number  
15 of pixels, which satisfies that the data difference in each  
pixel of each field between an output of the third memory 16  
and an output of the interlaced scanned image signal  
generation circuit 4 is less than or equal to a predetermined  
threshold, and detects the matching of fields if the count  
20 value is greater than or equal to a certain value. Such  
matching detection is indicated by the field comparison  
information shown in Figure 16. In this way, the matching  
detection is "1" every 5 fields. Therefore, when the  
matching detection circuit 15 detects a change in the field  
25 comparison information every 5 fields, the matching  
detection circuit 15 determines that the material of the  
image signal is of film.

The second material determination circuit 19  
30 determines whether the material of an image signal is a film  
material or video material, based on an output of the first  
material determination circuit 8 and an output of the  
matching detection circuit 15. As shown in Figure 14, even

after transition from the state where the first material determination circuit 8 determines that the image signal is of film material to the state where the first material determination circuit 8 determines that the image signal is of video material, if the matching detection circuit 15 determines that the material of the image signal is the film material, the second material determination circuit 19 determines that the material is the film material. Therefore, the second material determination circuit 19 determines that the  $n+2^{\text{th}}$  frame through the  $n+6^{\text{th}}$  frame are of film material in Figure 16. When the second material determination circuit 19 determines that the main image is of film material, the progressive scanning conversion circuit 17 performs the progressive scanning conversion in response to the repeat periodic signal generated by the repeat periodic signal generation circuit 18. Specifically, in the case of film material, for each frame of each material, an original image of  $720 \times 480$  dots is divided into 2 fields of  $720 \times 240$  dots, which may be synthesized again. Therefore, the progressive scanning conversion circuit 17 can detect the timing of switching of the frames of the film signal which is the material of an input digital image signal, using the repeat periodic timing signal shown in Figure 16. In response to the repeat periodic signal, the progressive scanning conversion circuit 17 stores the head field of the progressive scanning conversion circuit input shown in Figure 16 in the second memory 11 and the second field in the second memory 11, and reads out both information on a line-by-line basis at a double speed, thereby obtaining the progressive scanning conversion circuit output shown in Figure 16. The converted image signal is converted into an analog signal by the D/A converter 12. The resultant analog signal is

output through the progressive scanned image signal output terminal 13. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 13. The user can see the film material images restored to the progressive scanned image via the television monitor.

Therefore, the image signal reproduction apparatus according to Example 2 of the present invention can apply the progressive scanning conversion suitable for film material to an image signal of film material which has been partially recorded as a video signal of 60 fields per second.

Note that in the above-described description, the first, second, and third memories are separated for the purpose of explaining the functions thereof. All the memories can be realized using semiconductor memories. All or any two of the memories can be easily realized using a single semiconductor memory by proper arrangement of a circuit.

The above-described Examples are described as hardware arrangements, i.e., electronic circuits which are easy to explain signal flows, but are not necessarily limited thereto. All or part of the pickup 2 and the components having the reference numeral more than 2 may be constructed as software and implemented into a microprocessor, which can perform the same action and effect.

In the above-described Examples, the disk apparatuses reproduce the main image signal and the transfer information from a disk such as DVD or the like. Similarly, another image signal reproduction apparatus for reproducing

(or demodulating) the main image signal and the transfer information, such as a tape apparatus, a hard disk apparatus, or a broadcast receiver for satellite broadcast, ground-wave broadcast, cable television broadcast, or the like, can be implemented. Needless to say, the disk, tape, and ground wave may include audio information and the like other than the main image information and the transfer information.

10           In the above-described Examples, only in the case of the progressive scanned image output, the NTSC encoder 6 and the interlaced scanned image output terminal 7 are not necessarily required. However, in this case, the image signal cannot be input and recorded in a recording apparatus  
15           using only the interlaced scanning format such as the so-called VHS video format.

              Hereinafter, an example of the present invention where a signal recorded in a disk is reproduced using an  
20           information signal including either a first image signal or a second image signal will be described with reference to Figures 17 through 27.

(Example 3)

25           Figure 17 is a block diagram showing a configuration of an image signal reproducing apparatus according to Example 3 of the present invention. In Figure 17, reference numeral 201 denotes a disk on which either an image signal obtained by converting a film material image into an  
30           electrical signal or an image signal of which material is a video signal is recorded in an encoded and modulated signal form suitable for recording in advance. Reference numeral 202 denotes a pickup which converts the signal

recorded on the disk 201 into an electrical signal. Reference numeral 203 denotes a disk rotating device which rotates the disk 201 at a certain revolutions-per-minute suitable for the disk 201. Reference numeral 204 denotes  
5 an interlaced scanned video signal reproduction circuit which demodulates and decodes the image signal recorded on the disk 201, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 205 denotes an encoder (e.g., NTSC encoder) which converts the  
10 interlaced scanned image signal into an NTSC video format for an interlaced scanned image monitor (not shown) and outputs the result. Reference numeral 206 denotes an interlaced scanned image output terminal through which the reproduced interlaced scanned image is output.

15 Reference numeral 207 denotes a progressive scanned image signal conversion circuit which converts an output of the interlaced scanned image signal reproduction circuit 204 into a progressive scanned image signal and  
20 outputs the result. Reference numeral 208 denotes a first memory which is capable of storing a field of image signal and which is used in the operation of the progressive scanned image signal conversion circuit 207. Reference numeral 209 denotes a color difference converter which  
25 converts an output of the progressive scanned image signal conversion circuit 207 into a progressive scanned color difference signal and outputs the result. Reference numeral 210 denotes a progressive scanning image output terminal through which the progressive scanned image signal  
30 is output to an image display apparatus not shown.

Reference numeral 211 denotes a spatial filter 11 which changes an output of the progressive scanned image



signal conversion circuit 207 in accordance with outputs of the a filter characteristic setting section 213 and a material determination circuit 214. Reference numeral 212 is a second memory which is used for changing the vertical frequency characteristics of the spatial filter 211. Reference numeral 213 denotes the filter characteristic setting section which the user employs to set a characteristic of the spatial filter 211. Reference numeral 214 denotes the material determination circuit which determines whether an image signal recorded on the disk 201 is of film material or video material and controls the spatial filter 211.

The operation of the image signal reproduction apparatus thus constructed will be described. Figure 18 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the image signal reproduction apparatus according to Example 3 of the present invention. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480. Both have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

Figure 19 is a schematic signal diagram showing a structure of an image signal recorded in the disk 201 of the image signal reproduction apparatus according to Example 3 of the present invention. As shown in Figure 19, the image signal recorded in the disk 201 has two forms. Specifically, Figure 19a) shows a film material. In this case, the original material is a film image composed of 24 frames of pictures per second. Each frame of the film image is compressed and recorded onto the disk 201 as an image of 720x480 dots. Figure 19b) shows a video material image. In this case, the original material is an interlaced scanned image composed of 30 frames/60 fields per second. Each frame is an image of 720x480 dots, but interlaced, so that each field is an image of 720x240 dots. The field is compressed and recorded onto the disk 201.

When the material of the image signal recorded in the disk 201 is a film, 24 frames of images of 720x480 dots per second are recorded as recorded information. The interlaced scanned image signal reproduction circuit 204 reads the signal recorded on the disk 201 from an output of the pickup 202. As shown in Figure 19a-1), the film material images are recorded in the disk 201 in order of the frame numbers ...,  $n$ ,  $n+1$ ,  $n+2$ ,  $n+3$ , ....

The film material signal thus recorded is modulated and converted into an interlaced scanned image and output by the interlaced scanned signal reproduction circuit 204. This is because television monitors are most commonly used as an image display apparatus for home entertainment, and the display format is the interlaced scanning. Since the television monitor is designed to display a moving image

of 30 frames/60 fields per second, the interlaced scanning video signal reproduction circuit 204 converts 24 frames of images per second into 30 frames/60 fields per second and outputs the result.

5

Specifically, the interlaced scanning video signal reproduction circuit 204 divides each frame of recorded information into two interlaced scanned field images, odd and even, as shown in the interlaced scanned reproduced image output in Figure 19a-2). The interlaced scanning video signal reproduction circuit 204 further displays the head field after the last field of each frame so that 24 frames of film images per second are converted into the interlaced scanned images of 30 frames/60 fields per second which are output. The NTSC encoder 205 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced, and outputs it through the interlaced scanned image output terminal 206. A television monitor (not shown) is connected to the interlaced scanned image output terminal 206 so that the user can see the film material image converted into the interlaced scanned image on the monitor.

Further, the interlaced scanned image signal reproduced circuit 204 inputs the interlaced scanned image signal to the progressive scanned image signal conversion circuit 207. The progressive scanned image signal conversion circuit 207 stores the head field of the progressive scanning conversion circuit input shown in Figure 19a-2) in the first memory 208 and thereafter stores the second field in the first memory 208, and reads both information for each line at a double speed, thereby obtaining the progressive scanned image output shown in Figure 19a-3). Specifically, a signal at the last field

which displays the same signal as a signal at the head field for each frame in Figure 19a-2 is not converted in Figure 19a-3, but the head field and a field following the head field are converted into three consecutive fields. The  
5 converted image signal is converted into an analog signal by the color difference converter 209, and the resultant analog signal is output via the spatial filter 211 through the progressive scanned image signal output terminal 210. A television monitor (not shown) for the progressive scanned  
10 image signal is connected to the progressive scanned image signal output terminal 210. The user can see the film material images restored to the progressive scanned image via the television monitor.

15 In the case when the material of image signals recorded in the disk 201 is video, an interlaced scanned image of 30 frames/60 fields per second is recorded as recorded information, each field having a 720x240 dots image. The interlaced scanned image signal reproduction  
20 circuit 204 reads the signal recorded in the disk 201 from an output of the pickup 202, and modulates the signal and outputs the modulated signal as the interlaced scanned image signal shown in Figure 19b-2) without alteration.

25 The NTSC encoder 205 produces an NTSC standard video signal from the interlaced scanned image signal thus reproduced and outputs it through the interlaced scanned image output terminal 206. A television monitor (not shown) is connected to the interlaced scanned image output  
30 terminal 206 so that the user can see the film material image converted into the interlaced scanned image via the monitor.

Further, the interlaced scanned image signal

reproduced circuit 204 inputs the interlaced scanned image signal to the progressive scanned image signal conversion circuit 207. In the case of the video material, the progressive scanned image signal conversion circuit 207 generates a progressive scanned image signal using two pieces of field information, i.e., current field image information and the previous field. In this case, the progressive scanning conversion circuit 207 also uses data for the previous field to interpolate in the vertical direction with respect to pixels having small movements between the current and previous fields of the progressive scanned conversion circuit output shown in Figure 19b-2). With respect to pixels having large movements between the current and previous fields, vertical interpolated data is generated from upper and lower pixel data in the same field to obtain a progressive scanned image output shown in Figure 19b-3).

The converted image signal is converted into an analog progressive scanned color difference signal by the color difference converter 209. The analog progressive scanned color difference signal is output via the spatial filter 211 through the progressive scanned image signal output terminal 210. A television monitor (not shown) for the progressive scanned image signal is connected to the progressive scanned image signal output terminal 210 so that the user can see the video material image converted into the progressive scanned image via the monitor.

Figure 20 is a schematic diagram showing the vertical frequency characteristics of materials for the image signal reproduction apparatus according to an example of the present invention. In the case of the video material

to be interlaced scanned, each field has 240 lines, two fields having 480 lines. In the case of the film material, optical information recorded on the original film is converted into electrical information of 480 lines of progressive scanned signals. Therefore, the vertical frequency characteristics are of a high band region indicated by the characteristics of the film material shown in Figure 20. The film material image is supposed to be reproduced by the interlaced scanned receiver. Bandwidth is limited in advance in order to avoid feedback interference. As indicated by the characteristics of the film material after removing interlace interference, the vertical frequency characteristics are reduced to the same level as that of the characteristics of the video material, at which level the film material image is recorded.

Figure 21 is a block diagram showing a configuration of the spatial filter 211 of the image signal reproduction apparatus of Example 3 of the present invention. In Figure 21, reference numeral 215 denotes a vertical filter which changes the vertical frequency characteristics of the progressive scanned image signal. Reference numeral 216 denotes a horizontal filter which changes the horizontal frequency characteristics of the progressive scanned image signal. In Figure 17, an output of the progressive scanned image signal conversion circuit 207 is output via the spatial filter 211 to the color difference converter 209. In the spatial filter 211, the vertical and horizontal frequency characteristics are changed and output using a circuit shown in Figure 21.

Figure 22 is a block diagram showing a configuration of the vertical filter 215 of the image signal reproduction

apparatus of Example 3 of the present invention. In Figure 22, reference numeral 217 denotes a write control circuit which writes an input progressive scanned image signal to the second memory 212. Reference numeral 218 denotes a read control circuit which reads data from the second memory 212. Reference numeral 219 denotes a first group of registers which hold data read from the second memory 212 by the read control circuit 218. Reference numeral 220 denotes a first group of multipliers which multiply data in the first group of registers 219 by a preset coefficient, and output the results. Reference numeral 221 denotes a first adder which adds outputs of the first group of multipliers 220 and outputs the result. In Figure 22, the first group of registers 219, the first group of multipliers 220, and the first adder 221 constitute the filter. If data to be stored in the first group of registers 219 are arranged in a line in the vertical direction of the progressive scanned image signal, it is possible to obtain the vertical filter which can change the frequency characteristics in the vertical direction. Further, the ON and OFF of the function of the vertical filter can be externally controlled by changing the coefficients of the first group of multipliers 220.

Figure 23 is a schematic figure showing the characteristics of the vertical filter 215 of the image signal reproduction apparatus of Example 3 of the present invention. As shown in Figure 23, when the vertical filter is in the OFF state, the vertical frequency characteristics are flat. When the vertical filter is in the ON state, the vertical frequency characteristics are such that the high region is raised.

Figure 24 is a block diagram showing a configuration of the horizontal filter 216 of the image signal reproduction apparatus of Example 3 of the present invention. In Figure 24, Reference numeral 222 denotes a second group of registers which hold input data. Reference numeral 223 denotes a second group of multipliers which multiply data in the second group of registers 222 by a preset coefficient, and output the results. Reference numeral 224 denotes a second adder which adds the outputs of the second group of multipliers 223 and outputs the result. In Figure 24, the second group of registers 222, the second group of multipliers 223, and the second adder 224 constitute the filter. It is thus possible to obtain the horizontal filter which can change the frequency characteristics in the horizontal direction. Further, the ON and OFF of the function of the vertical filter can be externally controlled by changing the coefficients of the second group of multipliers 223 by input control.

Figure 25 is a schematic diagram showing the characteristics of the vertical filter 216 of the image signal reproduction apparatus of Example 3 of the present invention. As shown in Figure 25, when the horizontal filter 216 is in the OFF state, the horizontal frequency characteristics are flat. When the horizontal filter 216 is in the ON state, the horizontal frequency characteristics are such that the high region is raised.

In Figure 17, the material determination circuit 214 determines whether the image component of an information signal recorded on the disk 201 is of film material or of video material, and outputs the result to the spatial filter 211. The spatial filter 211 switches



the vertical filter ON when the material determination circuit 214 determines that the material recorded on the disk 201 is of film. The spatial filter 211 switches the vertical filter OFF when the material determination circuit 214 determines that the material recorded on the disk 201 is of video. Thus, the material determination circuit 214 output a progressive scanned image signal having an optimal characteristic each for film material and video material.

Further, in Figure 17, using the filter characteristic setting section 213, the user can arbitrarily provide the settings of the spatial filter 211, i.e., switch the ON and OFF of the vertical filter 215 and the horizontal filter 216.

Figure 26 is a schematic diagram showing an effect of the vertical filter 215 of the image signal reproduction apparatus of Example 3 of the present invention. As shown in Figure 26, the total characteristics of the film material when the vertical filter is in the OFF state is such that the high region is degraded due to the vertical filter 215. The total characteristics of the film material when the vertical filter is in the ON state is such that the vertical frequency characteristics are less degraded due to the vertical filter 215.

Figure 27 is a schematic diagram showing the frequency characteristics of visual appreciation of the interlaced scanned image and the progressive scanned image output of the image signal reproduction apparatus of Example 3 of the present invention. In general, a progressive scanning image monitor has twice as many the

number of the horizontal scanning frequency as that of an interlaced scanning image monitor. Therefore, the electrical and optical frequency bands required to attain the same resolution needs to be doubled. The double number of scanning lines leads to a characteristic in which visual impression is low resolution. Therefore, comparing the interlaced scanned image signal with the image signal obtained by converting the interlaced scanned image signal into the progressive scanned image signal, the latter image signal gives the user the impression that the frequency characteristics are poorer. However, the spatial filter 211 corrects and removes the difference in visual appreciation between the interlaced scanned image signal and the progressive scanned image signal. Particularly, in the conventional image signal reproduction apparatus, the interlaced scanned image and the progressive scanned image are output at the same time. Although both images can be easily compared with each other, there is no difference in visual appreciation between both images, which does not result in any detriment to the image signal reproduction apparatus.

Note that in the above-described description, the case where the input of the progressive scanned image signal conversion section is the output of the interlaced scanned image signal reproduction section is described. Information signals can be applied to a configuration in which the interlaced scanned image signal reproduction section and the progressive scanned image signal reproduction section are provided in parallel. Note that, in this case, the progressive scanned image signal reproduction section needs to include a scanned image signal reproduction section which demodulates and combines the

information signals to the progressive scanned image signal. The additional scanned image signal reproduction section leads to complications as compared with the above-described Examples.

5

Note that in the above-described description, the first and second memories are separated for the purpose of explaining the functions thereof. All the memories can be realized using semiconductor memories. All the memories can be easily realized using a single semiconductor memory by proper arrangement of a circuit.

10

The ON and OFF of the spatial filter is switched by both the filter characteristic setting section and the material determination circuit. The switching is not necessarily performed by both. Control either by the filter characteristic setting section or by the material determination circuit can lead to the effect of the present invention.

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Further, although the spatial filter is simply controlled and switched between ON and OFF, i.e., in two ways, the filter characteristics of the spatial filter may be switched between multiple stages.

25

Further, in Figure 17, each component denoted by reference numeral 4 or thereafter may be replaced with a microprocessor or the like and implemented by software.

30

Further, although the image signal reproduction apparatus is constructed as the disk apparatuses, another image signal reproduction apparatus, such as a tape apparatus or a broadcast receiver can be similarly

implemented.

(Example 4)

Figure 28 is a block diagram showing a configuration of an image signal reproducing apparatus according to an example of the present invention. In Figure 28, reference numeral 301 denotes a disk on which an image signal and the determination flag indicating the aspect ratio of the image signal are recorded in an encoded and modulated signal form suitable for recording in advance. Reference numeral 302 denotes a pickup which converts the signal recorded on the disk 301 into an electrical signal. Reference numeral 303 denotes a disk rotating device which rotates the disk 301 at a certain revolutions-per-minute suitable for the disk 301.

Reference numeral 304 denotes an interlaced scanned video signal reproduction circuit which demodulates and decodes the image signal recorded on the disk 301, and outputs the resultant signal as an interlaced scanned image signal. Reference numeral 305 denotes a material determination circuit which reads the determination flag recorded on the disk 301 from an output of the pickup 302.

Reference numeral 306 denotes a first aspect ratio conversion circuit which is controlled by a first control circuit 312 and which converts the aspect ratio of the input image signal and outputs the result. Reference numeral 307 denotes an NTSC encoder which converts the interlaced scanned image signal into an NTSC video format and outputs the result. Reference numeral 308 denotes an interlaced scanned image output terminal through which the reproduced interlaced scanned image is output.

Reference numeral 309 denotes a progressive scanned image signal conversion circuit which converts an output of the first aspect ratio conversion circuit 306 into a progressive scanned image signal and outputs the result. Reference numeral 310 denotes a color difference converter which converts an output of the progressive scanned image signal conversion circuit 309 into an analog color difference signal and outputs the result.

Reference numeral 311 denotes a progressive scanning image output terminal through which the progressive scanned image signal resulting from conversion is output. Reference numeral 312 denotes a first control circuit which controls the first aspect ratio conversion circuit 306 using an output of the material determination circuit 305 and an output of a first aspect ratio setting section 313. Reference numeral 313 denotes the first aspect ratio setting section which is used by the user to set the aspect ratio of the receiver.

Reference numeral 314 denotes a second aspect ratio setting section by which the user sets the aspect ratio of the image receiver. Reference numeral 315 denotes a second control circuit which controls a second aspect ratio conversion circuit 316 based on an output of the material determination circuit 305 and an output of the second aspect ratio setting section 314. Reference numeral 316 denotes a second aspect ratio conversion circuit which is controlled by the second control circuit 315 and converts the aspect ratio of an input image signal and outputs the result.

The operation of the image signal reproduction

apparatus thus constructed according to Example 4 of the present invention will be further described.

Figure 29 is a schematic diagram showing structures of the interlaced scanned image signal and the progressive scanned image signal in the image signal reproduction apparatus of Example 4 of the present invention. In the interlaced scanned image signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The pixels of one field are buried between the other fields in the vertical direction, and vice versa. In the progressive scanned signal, one frame is created in 1/60 second and the number of pixels in the vertical direction is 480.

Both have a vertical frequency of 1/60 second. The number of horizontal scanning lines of the progressive scanned image signal is twice as many as that of the interlaced scanned image signal. The horizontal scanning frequency of the interlaced scanned image signal is about 15.75 KHz, while that of the progressive scanned image signal is about 31.5 KHz.

Figure 30 is a schematic signal diagram showing the aspect ratio of an image signal of the image signal reproduction apparatus of Example 4 of the present invention. As shown in Figure 30a), the image signal of image source recorded in the disk 301 has three forms. Specifically, Figure 30a)a-1) shows a 4:3 full image having information which fills a full screen of 4:3. Figure 30a)a-2) shows a 4:3 letterbox image having an image of 16:9 in the middle of the 4:3 screen, the upper and lower

portions being shaded. Figure 30a)a-3) shows a 16:9 image having information which fills a full screen of 16:9.

5 Figure 30b) shows the aspect ratio of the monitors for the interlaced scanned image signal. As shown in Figure 30b), there are two types of monitor for the interlaced scanned image signal, one type shown in Figure 30b)b-1) having an aspect ratio of 4:3 and the other shown in Figure 30b)b-2) having an aspect ratio of 16:9.

10

Figure 30c) shows the aspect ratio of the monitors for the progressive scanned image signal. As shown in Figure 30c), there are two types of monitor for the progressive scanned image signal, one type shown in Figure 30c)c-1) having an aspect ratio of 4:3 and the other shown in Figure 53c)c-2) having an aspect ratio of 16:9.

15

The interlaced scanned image signal reproduction circuit 304 reads a signal recorded on the disk 301 from an output of the pickup 302, reproduces the interlaced scanned image signal, and outputs the result to the first aspect ratio conversion circuit 306. The material determination circuit 305 reads the determination flag from an output of the pickup 302, determines the type of the image signal, and outputs the result as the determination signal to the first control circuit 312.

20

25

The user sets the aspect ratio of a monitor via which the user intends to output the image signal, using the first aspect ratio setting section 313. The first control circuit 312 controls the first aspect ratio conversion circuit 306 using an output of the material determination circuit 305 and an output of the first aspect ratio setting

30

section 313.

Figure 31 is a schematic diagram for explaining the operation of the first aspect ratio conversion circuit 306 of the image signal reproduction apparatus according to Example 4 of the present invention.

Assuming that the monitor has an aspect ratio of 4:3, the first aspect ratio conversion circuit 306 has a function which compresses a material having an aspect ratio of 16:9 in the vertical direction. Specifically, in order to display the 16:9 material on the 4:3 monitor at the correct aspect ratio, 4 lines of information of an input image signal are subjected to a filtering process so that 3 lines of information are generated. Such a process is performed for the entire screen, so that the entire screen is compressed in the vertical direction. In this case, the aspect ratio is correctly converted for the 16:9 screen, but leaving blanks in the upper and lower portions. Such portions are rendered as black images. The aspect ratio conversion function can select a working or non-working state using the first control circuit 312. In the case of the non-working state, the first aspect ratio conversion circuit 306 outputs the input image signal without the aspect ratio conversion.

In Figure 28, the user sets the aspect ratio of the monitor for display to 4:3 or 16:9 using the first aspect ratio setting section 313. On the other hand, the material determination circuit 305 outputs the aspect ratio of the image source, i.e., which it is, the 4:3 full screen, the 4:3 letterbox screen or the 16:9 screen, to the first control circuit 312.



5       The first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio conversion circuit 306 to be in the non-working state when the aspect ratio of the image source of the material determination circuit 305 is the 4:3 full image or the 4:3 letterbox image.

10       The first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio conversion circuit 306 to be in the non-working state when the material determination circuit 305 indicates that the aspect ratio of the image source of is 16:9 and the first aspect ratio setting section outputs 16:9.

15       The first control circuit 312 causes the aspect ratio conversion operation of the first aspect ratio conversion circuit 306 to be in the working state when the material determination circuit 305 indicates that the aspect ratio of the image source is 16:9 and the first aspect ratio setting section outputs 4:3.

20       The NTSC encoder 307 converts an output of the first aspect ratio conversion circuit 306 to the NTSC video format. The interlaced scanned image output is output through the interlaced scanned image output terminal 308 to the interlaced scanned image monitor (not shown).

30       Figure 32 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 4:3 full image in the image signal reproduction apparatus of Example 4 of the present invention. As shown in

Figure 32b-1, the correct aspect ratio is displayed on the 4:3 monitor. However, as shown in Figure 32b-2, the 16:9 monitor does not display the correct aspect ratio, so that the displayed image is extended horizontally. The interlaced scanned image monitor includes a 4:3 output switch function since the standard aspect ratio of the conventional interlaced scanned image signal is 4:3. The interlaced scanned image monitor can display as shown in Figure 32b-3 at the correct 4:3 aspect ratio using the 4:3 output switch function.

Figure 33 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 4:3 letterbox image in the image signal reproduction apparatus of Example 4 of the present invention. As shown in Figure 33b-1, the correct aspect ratio is displayed on the 4:3 monitor. However, as shown in Figure 33b-2, the 16:9 monitor does not display the correct aspect ratio, so that the displayed image is extended horizontally. The interlaced scanned image monitor includes a 4:3 letterbox image output switch function since the standard aspect ratio of the conventional interlaced scanned image signal is 4:3. The interlaced scanned image monitor can display as shown in Figure 33b-3 at the correct 16:9 aspect ratio using the 4:3 output switch function.

Figure 34 is a schematic diagram for explaining the aspect ratio of an image displayed on the interlaced scanned image monitor in the case of the image source having the 16:9 image in the image signal reproduction apparatus of Example 4 of the present invention. As shown in Figure 34b-1, the aspect ratio with no change is not

correctly displayed on the 4:3 monitor, so that the displayed image is extended vertically. However, if the user sets the fact that a monitor to be connected is 16:9, to the first aspect ratio setting section, the first aspect ratio conversion circuit 306 is activated. The aspect ratio is converted so that the image is correctly displayed as shown in Figure 34b-4. In addition, as shown in Figure 34b-2, the 16:9 monitor displays the image at the 16:9 aspect ratio.

Specifically, the interlaced scanned image monitor can display at the correct aspect ratio any combination of 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types image monitor, i.e., the 4:3 monitor and the 16:9 monitor.

An output of the first aspect ratio conversion circuit 306 is input to the progressive scanned image signal conversion circuit 309. The progressive scanned image signal conversion circuit 309 converts the input interlaced scanned image signal to the progressive scanned image signal, and outputs the result.

Figure 35 is a schematic diagram for explaining the operation of the second aspect ratio conversion circuit 316 of the image signal reproduction apparatus of Example 4 of the present invention.

Assuming that the monitor has an aspect ratio of 16:9, the second aspect ratio conversion circuit 306 has a horizontal aspect ratio conversion function which compresses the 4:3 full image in the horizontal direction. Specifically, in order to display the 4:3 material on the 16:9 monitor at the correct aspect ratio, 4 pixels of

information of an input image signal are subjected to a filtering process so that 3 pixels of information are generated. Such a process is performed for the entire screen, so that the entire screen is compressed in the horizontal direction. In this case, the aspect ratio is correctly converted for the 4:3 screen, but leaving blanks in the right and left portions. Such portions are rendered as black images.

10            Assuming that the monitor has an aspect ratio of 16:9, the second aspect ratio conversion circuit 306 has a vertical aspect ratio conversion function which compresses the 4:3 letterbox image in the vertical direction. Specifically, in order to display the 4:3 letterbox image on the 16:9 monitor at the correct aspect ratio, 3 pixels of information of an input image signal are subjected to a filtering process so that 4 pixels of information are generated. Such a process is performed for the entire screen, so that the entire screen is expanded in the vertical direction, thereby being converted into the 16:9 screen.

25            The two aspect ratio conversion functions each can select a working or non-working state using the second control circuit 312. In the case of the non-working state of both conversion functions, the second aspect ratio conversion circuit 316 outputs the input image signal without the aspect ratio conversion.

30            In Figure 28, the user sets the aspect ratio of the monitor for display to 4:3 or 16:9 using the first aspect ratio setting section 313 and the second aspect ratio setting section 314. On the other hand, the material determination circuit 305 outputs the aspect ratio of the

image source, i.e., which it is, the 4:3 full screen, the 4:3 letterbox screen or the 16:9 screen, to the second control circuit 315.

5           The second control circuit 315 causes both the horizontal and vertical aspect ratio conversion operations of the second aspect ratio conversion circuit 316 to be in the non-working state when the aspect ratio of the image source of the material determination circuit 305 is the 4:3 full image or the 4:3 letterbox image and the output of the  
10           second aspect ratio setting section 314 is 4:3.

          The second control circuit 315 causes the horizontal and vertical aspect ratio conversion operations  
15           of the second aspect ratio conversion circuit 316 to be in the working state and in the non-working state, respectively, when the material determination circuit 305 indicates that the aspect ratio of the image source of is the 4:3 full image and the second aspect ratio setting section 314 outputs  
20           16:9.

          The second control circuit 315 causes the vertical and horizontal aspect ratio conversion operations of the second aspect ratio conversion circuit 316 to be in the  
25           working state and in the non-working state, respectively, when the material determination circuit 305 indicates that the aspect ratio of the image source of is the 4:3 letterbox image and the second aspect ratio setting section 314 outputs 16:9.

30           The second control circuit 315 causes both the horizontal and vertical aspect ratio conversion operations of the second aspect ratio conversion circuit 316 to be in

the non-working state when the aspect ratio of the image source of the material determination circuit 305 is the 16:9 image.

5           The color difference converter 310 converts the progressive scanned image signal to a color difference image signal, and outputs the progressive scanned image output through the progressive scanned image output terminal 311 to the progressive scanned image monitor (not shown).

10

Figure 36 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned image monitor in the case of the image source having the 4:3 full image in the image signal reproduction apparatus of Example 4 of the present invention. As shown in Figure 36c-1, the aspect ratio is correctly displayed on the 4:3 monitor. However, the aspect ratio with no change is not correctly displayed on the 16:9 monitor, so that the displayed image is extended horizontally. Here, the progressive scanned image 16:9 monitor is a monitor intended to receive a high-definition television signal, and does not include the 4:3 output mode. In this case, however, if the user sets the fact that a monitor to be connected is 16:9, to the first and second aspect ratio setting sections 313 and 314, the horizontal aspect ratio conversion function of the second aspect ratio conversion circuit 316 is activated, an image converted into a correct aspect ratio can be displayed as shown in Figure 36c-3.

30           Figure 37 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned image monitor in the case of the image source having the 4:3 letterbox image in the image signal reproduction

apparatus of Example 4 of the present invention. As shown in Figure 37c-1, the aspect ratio is correctly displayed on the 4:3 monitor. As shown in Figure 37c-2; however, the aspect ratio with no change is not correctly displayed on the 16:9 monitor, so that the displayed image is extended horizontally. The progressive scanned image 16:9 monitor is a monitor intended to receive a high-definition television signal, and does not include the 4:3 output mode. The 16:9 standard aspect ratio of the high-definition television signal is not displayed at the correct aspect. In this case, however, if the user sets the fact that a monitor to be connected is 16:9, to the first and second aspect ratio setting sections 313 and 314, the vertical aspect ratio conversion function of the second aspect ratio conversion circuit 316 is activated, an image converted into a correct aspect ratio and into a full screen can be displayed as shown in Figure 37c-3.

Figure 38 is a schematic diagram for explaining the aspect ratio of an image displayed on the progressive scanned image monitor in the case of the image source having the 16:9 image in the image signal reproduction apparatus of Example 4 of the present invention.

As shown in Figure 38c-1, the aspect ratio with no change is not correctly displayed on the 4:3 monitor, so that the displayed image is extended vertically. However, if the user sets the fact that a monitor to be connected is 4:3, to the first and second aspect ratio setting sections 313 and 314, the first aspect ratio conversion circuit 306 is activated. The aspect ratio is converted so that the image is correctly displayed as shown in Figure 38c-4. In addition, as shown in Figure 38c-3, the

16:9 monitor displays the image at the 16:9 aspect ratio.

5 In other words, in the image signal reproduction apparatus of Example 4 of the present invention, the progressive scanned image monitor can display at the correct aspect ratio any combination of the image sources of the 4:3 full image and the 4:3 letterbox image with the 4:3 and 16:9 image monitors.

10 Note that, in the present invention, the image sources are limited to the 3 types, i.e., the 4:3 full image, the 4:3 letterbox image, the 16:9 image. If the aspect conversion function of the second aspect ratio conversion circuit is changed in accordance with the aspect ratio of  
15 the source, 3 or more types of image sources may be used.

Further, in Figure 28, each component having reference numeral 304 or thereafter is in the form of a circuit in Example 4, which may be replaced with software.  
20

Further, in Example 4, the description is given of the image signal recorded on a disk medium. The present invention can also be applied to other tape media, and information media including an image signal, such as  
25 satellite broadcast and ground-wave broadcast.

#### INDUSTRIAL APPLICABILITY

As described above, according to the present invention, an image signal reproduction apparatus is  
30 provided which includes a section which determines the type of a material using the field repeat signal generated when converting the film material into an interlaced scanned image signal and the determination flag for determining the



type of the main image signal, and a section which determines whether a material signal is of film or video using an image signal which has been once converted into an interlaced scanned image signal. Using the determination results of both sections, the determination of the material is performed. Therefore, the image signal reproduction apparatus can apply the progressive scanning conversion suitable for film material to an image signal of film material which has been partially recorded as a video signal of 60 fields per second.

Further, according to the present invention, an image signal reproduction apparatus is provided which includes an interlaced scanned image signal reproduction section which outputs an image signal as an interlace scanned image signal of 60 fields per second, a progressive scanning conversion section which converts an image signal to a progressive scanned image signal, and a filtering section which changes the frequency characteristics of the output of the progressive scanning conversion section. Therefore, the image signal reproduction apparatus can output a progressive scanned image with a resolution close to the original film and with less degradation of resolution compared with the interlaced scanned image even in visual appreciation, after subjecting the film material image signal to progressive scanning conversion.

Still further, according to the present invention, an image signal reproduction apparatus is provided which includes a second aspect ratio conversion circuit which compresses an image in the horizontal or expands an image in the vertical direction after progressive scanned image signal conversion, a second aspect ratio setting section

1973-74	24,000	1983-84	4,500	1993-94	2,000
75	25,000	85	5,000	95	2,500
76	26,000	86	5,500	96	3,000
77	27,000	87	6,000	97	3,500
78	28,000	88	6,500	98	4,000
79	29,000	89	7,000	99	4,500
80	30,000	90	7,500	00	5,000
81	31,000	91	8,000	01	5,500
82	32,000	92	8,500	02	6,000
83	33,000	93	9,000	03	6,500
84	34,000	94	9,500	04	7,000
85	35,000	95	10,000	05	7,500
86	36,000	96	10,500	06	8,000
87	37,000	97	11,000	07	8,500
88	38,000	98	11,500	08	9,000
89	39,000	99	12,000	09	9,500
90	40,000	00	12,500	10	10,000
91	41,000	01	13,000	11	10,500
92	42,000	02	13,500	12	11,000
93	43,000	03	14,000	13	11,500
94	44,000	04	14,500	14	12,000
95	45,000	05	15,000	15	12,500
96	46,000	06	15,500	16	13,000
97	47,000	07	16,000	17	13,500
98	48,000	08	16,500	18	14,000
99	49,000	09	17,000	19	14,500
00	50,000	10	17,500	20	15,000
01	51,000	11	18,000	21	15,500
02	52,000	12	18,500	22	16,000
03	53,000	13	19,000	23	16,500
04	54,000	14	19,500	24	17,000
05	55,000	15	20,000	25	17,500
06	56,000	16	20,500	26	18,000
07	57,000	17	21,000	27	18,500
08	58,000	18	21,500	28	19,000
09	59,000	19	22,000	29	19,500
10	60,000	20	22,500	30	20,000
11	61,000	21	23,000	31	20,500
12	62,000	22	23,500	32	21,000
13	63,000	23	24,000	33	21,500
14	64,000	24	24,500	34	22,000
15	65,000	25	25,000	35	22,500
16	66,000	26	25,500	36	23,000
17	67,000	27	26,000	37	23,500
18	68,000	28	26,500	38	24,000
19	69,000	29	27,000	39	24,500
20	70,000	30	27,500	40	25,000
21	71,000	31	28,000	41	25,500
22	72,000	32	28,500	42	26,000
23	73,000	33	29,000	43	26,500
24	74,000	34	29,500	44	27,000
25	75,000	35	30,000	45	27,500
26	76,000	36	30,500	46	28,000
27	77,000	37	31,000	47	28,500
28	78,000	38	31,500	48	29,000
29	79,000	39	32,000	49	29,500
30	80,000	40	32,500	50	30,000
31	81,000	41	33,000	51	30,500
32	82,000	42	33,500	52	31,000
33	83,000	43	34,000	53	31,500
34	84,000	44	34,500	54	32,000
35	85				